SCIENTIFIC AMERICAN SUPPLEMENT. No 1631

Entered at the Post Office of New York, N. Y., as Second Class Matter.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXIII., No. 1631

NEW YORK, APRIL 6, 1907.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year

MARBLE CANYON, ROUTE OF THE OLD TRAIL TO OWENS LAKE VALLEY.

THE DESERTS OF NEVADA AND THE DEATH VALLEY.

THE DESERTS OF NEVADA AND THE DEATH VALLEY.*

By ROBERT H. CHAPMAN, United States Geological Survey.

THE area lying to the west and southwest of Salt Lake City and extending to the Sierra Nevada and the ranges east of Los Angeles was for a long time included under the caption "The Great American Desert."

PLATEAU IN THE GREAT DRY AREA, SHOWING THE SOUTHERN END OF THE BELTED RANGE FROM OAK SPRING BUTTE.

The discovery of gold in California in 1849 was the beginning of the conquest of this thirsty region, the direction of greatest travel being but little south of west from Great Salt Lake to the vicinity of the Donner Pass in the Sierra Nevada, since used by the Central Pacific Railroad in crossing this range. In seeking for better routes to the new El Dorado, parties journeyed southward across the wastes of sand and rock searching for the lower passes which would be perennially available. In this direction the number of mountain ranges to be crossed is largely increased, but by going well southward the great wall of the Sierra Nevada is escaped, though the desert journey is very much lengthened and the hardships encountered by many parties were most appalling.

The desert took frequent toll in the lives of man and beast, and indeed does sometimes to-day, though the dangers are now comparatively insignificant.

With the discovery of the Comstock mines there came a period of tremendous activity in the search for the precious metals, more particularly for silver, and much of the desert region was traversed by the hardy prospector and his burro. In this way the long distances between watering places were divided by the discovery of springs and "tanks" (natural reservoirs), and gradually this part of the "American Desert" diminished in area and lost some of its fearfulness.

In the 60's and 1871-72 government expeditions under Lieut. George M. Wheeler traversed several routes across the desert, making topographic sketches and notes of interest and value, but few complete maps were printed. In 1865, and several times since then, the boundary line between Nevada and California was run, which cut through much of the most difficult country. The reports of and the stories by members of these expeditions did not tend to populate the region with great rapidity.

In many instances the prospectors were successful, and the camps of Silver Peak, Lida (or Allida), Reveille, and others sprang up, and had their periods of rise, prosperity, and decline, many becoming completely uninhabited.

During the period of activity many travelers became permanent residents, took to wife dusky maidens from the Indian tribes, and located ranches at various springs and streams, oases in the expanse of waste, where small herds of cattle or horses were maintained.

From the eastward the Mormons pushed gradually away from the streams of southern Utah and established farms and ranches at such places as furnished water, but there is a belt of country one hundred miles or more in width between these points and the water-fed valleys at the foot of the Sierra Nevada, which is almost wholly barren and very dry.

*An address to the National Geographic Society. Republished by permission of the author.

RENEWED INTEREST IN THE DESERTS.

During the last few years, beginning with the discovery of valuable ore at Tonopah (in May, 1900), the attack upon the desert has been renewed with great vigor and earnestness, and the efforts of the seekers of Fortune met with so much success and at such widely separated points that it was decided by the officers of the Geological Survey to put parties in the field to make a reconnaissance of some of the unmapped desert area.

The area where work was done lies about 200 miles southeast of Carson City, about 350 miles southwest of Salt Lake, and 250 miles northeast of Los Angeles. It comprises about 8,600 square miles and has a great range in elevation; the highest point reached is 9,500 feet above and the lowest about 300 feet below the level of the sea.

The idea of the person unacquainted with American deserts is of a great plain, sand-covered or rock-littered, with nothing to relieve the monotony of the horizon. As a matter of fact, these great areas include mountain ranges, high plateaux, mesas, and buttes, extensive valleys, that in the clear air seem but a short distance across. Many of these valleys are "closed"—have no outlet—and the lowest pass from one to another is often many hundred feet above the valley floor. The flowing streams are very few, the springs far between, and water a commodity for which men search, often with life at stake.

The map includes an area, almost equal to the total area of Delaware and Rhode Island, [illegible] 3,000 square miles that is waterless except for small holes that may be filled by occasional rains.

LIFE IN GOLDFIELD, NEVADA.

In entering the desert area the party traveled by rail to Tonopah, and thence by auto to Goldfield, which a short time ago was but a cluster of tents, and here headquarters camp was established. The town lies at an elevation of 5,700 feet, in a basin between the foot of Columbia Mountain and a mesa edge several hundred feet high. The immediate vicinity is not of great ruggedness, differences of 800 feet being extreme, though eight miles westward the Montezuma Peak rises to a height of 8,400 feet above sea.

THE TOWN OF KAWICH, SHOWING QUARTZITE MOUNTAIN IN THE BACKGROUND.

Since January, 1905, the town, together with its sister, Columbia, has "boomed" and quieted, and been "born again" to a steady, healthy growth. The demands of business are such as to warrant the erection of substantial buildings of wood and stone; there is at least one church, an ice plant, a swimming pool, a brewery, a club; pipe lines bring water from distant springs, and there are the numerous sources of amusement common to all new mining camps; every bar and hotel has its roulette wheel and corps of players, "cappers," etc. Here one may eat most of the dainties of the season—fruits from California, vegetables from Utah, fresh meat from Chicago; he may drink almost any brand of wine or any mixture of liquors to be found anywhere, while selections from the latest operas are rendered on violins and piano. One meets men from every part of the globe—prospectors from Alaska, mining engineers from London and Africa, business men from every large city, and the burros, "angels" of the desert, are universally present. There are numerous mines producing ore, some of which is shipped for treatment, some crushed in local "custom" mills, and some by mills controlled and operated by the owners of the mines. (Gasoline is used for power in most cases; wood retails at $18.00 per cord.)

Insurance is unknown, regular companies declining the risk. On a windy day in July (8th, 1905) a fire was started which destroyed several blocks of tents and buildings. It is a matter of interest that at least one building was saved by using beer to prevent its

THE DEATH VALLEY; SURVEYOR'S WELL, 65 FEET BELOW SEA LEVEL, DUNES AND MESQUITE ROOTS.

THE DESERTS OF NEVADA AND THE DEATH VALLEY.

igniting; the bottles were thrown against the building as modern grenades are used. One week later the town of Columbia was severely damaged by fire, the roaring flames, flying sparks, with pyrotechnic explosions of dynamite, making a scene to be remembered.

It is the dustiest vicinity I have seen, and when one of the many "twisters" (cyclones often of no mean proportion) strikes one, he can only "shut up" everything about himself and do no breathing until it goes by.

Provisions are high-priced and hay worth 2 cents to 3 cents per pound.

With the advent of the railroad in Goldfield, and from this point to outlying camps, the means of transportation is varied—for the passenger the modern high-power automobile or the more primitive stage-coach. For freight supplies of all kinds for man and beast, traction engines hauling trains of wagons, or several coupled wagons drawn by six to eighteen horses or mules, are used.

Nowhere in the world can one find greater contrasts than in this region. But a few miles from town one may ride or drive for hours—perhaps days—without meeting a human being, his eyes aching with the brazen glare and the monotony of the billowing hills and mountains, which hours of travel seem to bring no nearer.

THE STONEWALL FLAT.

From Goldfield the work of mapping takes us to the eastward, away from the auto and freight roads to Bullfrog and the southern camps. Across the Stonewall flat—a great inclosed valley, with its playa bottom of baked mud as hard and as smooth as concrete and as white as snow—is the Cactus Range, which extends in a northwest-southeast direction, with a rugged rock cone at the north end, known as Cactus Peak, which is a landmark for an area of a thousand square miles. An example of the uselessness of the maps of the region is here apparent; all these show the Cactus Peak to be to the south of Cactus Spring, which is the first water east of and 25 miles from Goldfield, while in reality the water is eight miles south of the mountain. This spring we find to be high in the range, and in this it is typical. Palatable water is seldom found in the flats or valleys unless sought by wells of considerable depth (100 to 200 feet). This range is made up of a series of volcanic flows, and near the Cactus Spring we find a fine example of basalt or rhyolite, columnar structure, lying like cordwood beside the road.

The Cactus Range is separated from the Kawich Range by a great valley, like that of Stonewall, long slopes of gravel and drift reaching from the ranges to the flats in the middle, which, as looked upon during the day, swing, rise and fall, in hazy heat waves like the billows of the sea. Toward the north end of the Kawich Range, at the new townsite of Silverbow, we find a stream of running water, and we push on to get above the camp and pitch our tents below the ragged cliffs.

At Silverbow and vicinity there are several hundred men, a few women, many good prospects, and much hope. The place is about as comfortable as any in the region, but desert prices prevail; hay is worth $80 per ton in bulk and grain $5 per sack (of 75 pounds).

To the east is the trail to "Eden," which we follow, crossing the Kawich Range, the highest peak of which is 9,500 feet.

From the pass we look along the summit, which is flat and broad—the remnant of an old surface which has been much eroded. We find the "town" to be a scattering lot of tents, but aptly named, for there is a small creek of running water, green, fresh grass, willows and small cottonwood trees, rose bushes, ferns, and grateful shade. The first man we greet states his name to be Adam(s), and asks us if we have seen any snakes, of which he assures us there are plenty, but Eve and apples we do not find.

The prospectors here show us claims, some having ores of gold and others of rich silver. We spend some days in mapping this country and examining the rocks, and then take up our journey southward along the range, which is usually supplied with timber, springs, and grass. Here there are numerous bands of horses, some of them wild, others acquiring wildness, and in turn endeavoring to thrust wildness upon the beasts of the traveler (three of ours strayed and are not even yet recovered). At one spring seven dead animals are found, killed by the shots of the stock-owners, who wish the water for beasts of use and value. Like the Cactus, this range is largely made up of volcanic flows.

We cross the Kawich Range on the pass above the "Wild Rose" Spring, and camp at the Sumner Spring, where there is water and wood, and after removing various rats, gophers, and insects from the spring, we are well located, with a beautiful view of the Reveille Range, which rises 3,000 feet above the valley to the eastward. In the desert it is very difficult to get satisfactory photographs—the distances are so great that the picture may include a whole range, miles away and several thousand feet high, but there is nothing to give scale to the view—nothing by which one can measure it. In the Reveille and adjacent valleys antelope are sometimes seen, but animal life is not abundant.

REVEILLE PEAK AND RANGE FROM SUMNER SPRING.

From Sumner Spring we journey by buckboard to the Reveille Range, which is crossed by the steepest wagon road I have ever seen. Over this road the ores from the mining camp, Old Reveille, were hauled to the mill in the valley, 16 miles away.

At the top of the mountain we look across another rolling summit of volcanic rocks; near by are a few buildings, a new boarding house, and several wooden shelters. Here "outside" capital is interested in the development of "prospects"; the water is hauled four miles, from the spring at the "Old Camp," which thirty years ago was a busy town, but now going to decay.

Horses and mules unaccustomed to the region are afraid of the deserts, and it is often very difficult to get them started over an unknown road when leaving a good campground behind; a nerve-wrecking delay may follow and heroic measures become necessary. Some of our animals lay "hog tied" in the cooking sun for hours before proceeding over a new route.

KAWICH—A GOLD CAMP.

While the northern end of the Kawich Range is well supplied with water, grass, and trees, the southern part is dry and barren. Here, about 80 miles from Goldfield, at the foot of Quartzite Mountain, some of the ledges of rhyolite which show through the drift carry gold, and as this is the magician that turns a desolate waste into a semblance of civilization, we find a camp, complete, yet lacking everything. The description of an investor from Italy I quote: "Kawich is a h—ll of a place! No mines, no water, no feed, no women," which discloses one point of view.

The water is hauled by team from Cliff Springs, 12 miles away, making a journey of 25 miles a day to keep the town from drying up, and is sold at $3.00 per barrel. (Extensive bathing is not generally practised.) If this spring fails, the wagons go to the Wild Rose Spring, 16 miles distant.

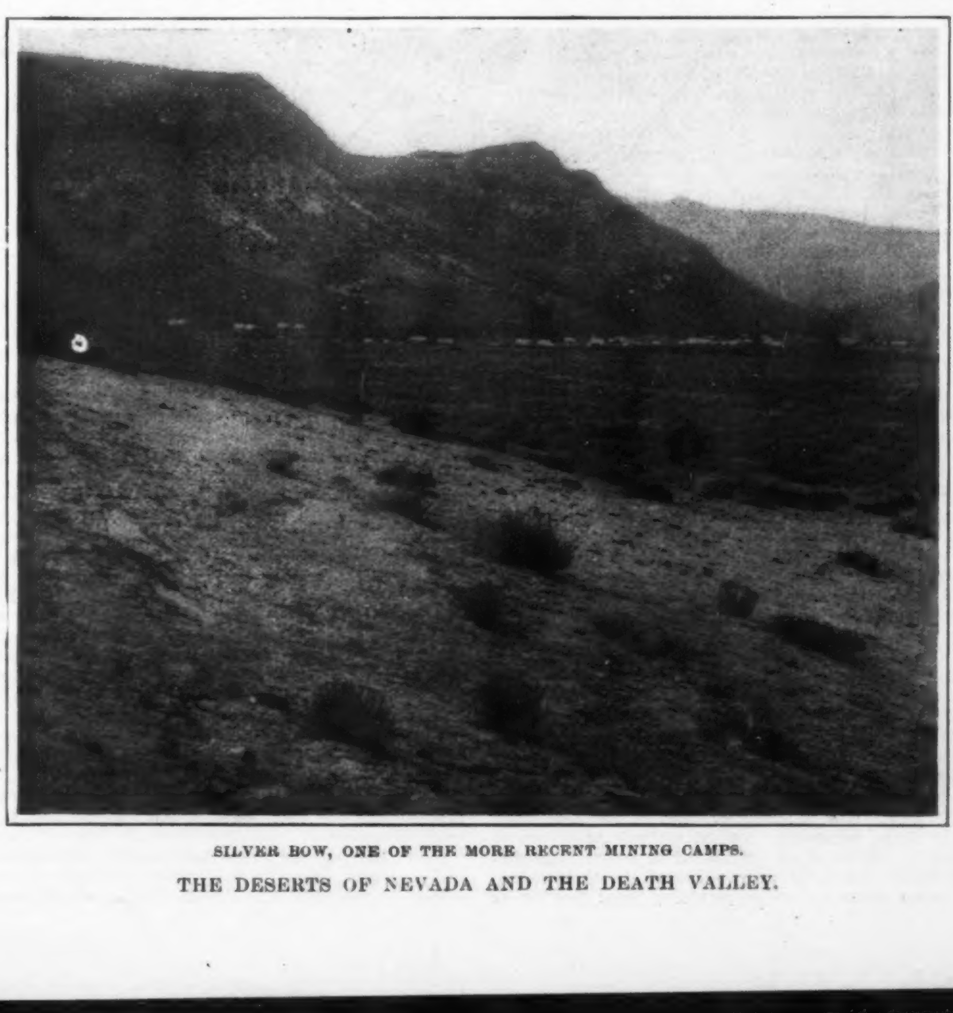
At the Gold Reed Mine we see some very beautiful gold ore; the metal occurs in a ledge of rhyolite which is highly silicified, and there is so much of it that none need ask to see it.

The Belted Range lies east of the Kawich Valley. It is composed of volcanic rocks, which weather in cliff forms that are very beautiful, many reaching 1,500 feet in height. Many rocks show columnar structure, horizontal, curved, and vertical, when looked at more closely.

The valley at Kawich extends southward many miles, and then rises to a high table-land which breaks abruptly to the south, forming a mesa front. To the eastward the Belted Range runs about north and south, and where it joins the mesa land the Oak Spring lies. A butte known as Oak Spring Butte rises just north of this water—a landmark; it is at once an aggravation and a comfort to the traveler, as he can see it for miles, and journey apparently toward it, circle around it, but not reach it.

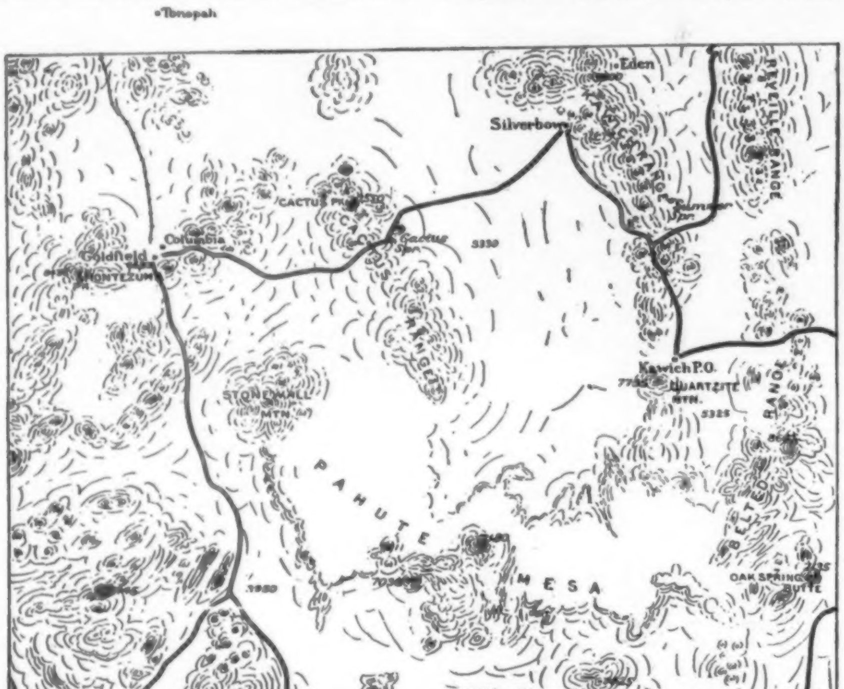
Oak Springs is about sixty miles by wagon road from Kawich, with but one small spring between and a road heavy with sand. It is a wearying journey at best, and men and animals are glad indeed when camp is pitched. Here there are prospects of gold and of copper; azurite fine enough to be cut and set in jewelry is found, and some of it has been shipped for that purpose.

From the top of the Oak Spring Butte a panorama of interest unfolds: To the west and north the high plateau region, besprinkled with scattering cedar and



SILVER BOW, ONE OF THE MORE RECENT MINING CAMPS.

THE DESERTS OF NEVADA AND THE DEATH VALLEY.



The Death Valley Region, Nevada

THE DESERTS OF NEVADA AND THE DEATH VALLEY.

piñon trees, cut by sharp-walled canyons, and limited by the backbone of the Belted Range is one of the most arid parts of the desert. To the east and south is the long sweep of an unnamed valley, the slopes of drift reaching from rock-walled range to the white enamel lake bed far in the distance. Across this valley we journey. The road, often sandy and slow, is relieved by stretches hard and smooth, which are in themselves a rest to horse and rider. In the bottom we find a great tank of water; it resembles a stream without flow, head, or mouth. The water surface is perhaps 200 yards long, 2 to 5 yards wide, and has a maximum depth of 3 feet. We are fortunate in that a fierce thunderstorm with heavy rain passed a day or so before and filled to overflowing this reservoir, which had been dry for months. The water is already dark brown and alkaline, but we fill every canteen and barrel and journey onward for the next permanent water.

The road rises slowly to pass between low buttes, and we find ourselves surrounded by giant yucca, or Joshua, trees; some of them are large and spreading, but give little more shade than a barbed-wire fence.

When we reach the Cane Spring, one of the watering places on the old emigrant road—when to reach it from the north a dry journey of 70 miles was necessary—it has taken us three days from Oak Springs, and the distance is not more than 35 miles. Here the tired, emaciated horses rest, wander in the barren hills seeking grass and finding sage brush, greasewood, and creosote bush.

Grain, which should have reached us, has not come, and we are distressed and worried lest more animals die and leave us stranded. We estimate it is 40 miles to the nearest hay—at a stage station on the freight road from Las Vegas to Bullfrog. We choose a light wagon, the four freshest animals, and succeed in getting back with a few bales in time to keep our bony quadrupeds from starvation.

For many weeks we have been skirting the edge of the area indicated as dry. It has been necessary to make small shelter camps far within the area and to haul water many miles across the trackless flats.

There are quite a number of animals that leave tracks and marks near the water-holes. During certain months thousands of wild doves flock from desert flat or bench land to spring or tank. These flights and rabbit trails converging toward a single point are of great assistance to one in search of water. Humans use many devices—usually heaps of stones or cairns or small sticks placed as pointers; these may be of great comfort or encouragement, though if the tank proves dried up, or to have been emptied by some wandering prospector to save his burros and fill his canteen, much distress and anxiety may follow.

From the Cane Spring we turn westward, and the Grapevine Range before us rises 3,000 feet from the Amargosa Desert—a great sand dune, long a landmark to the traveler from Ash Meadows to Beatty Ranch—stands in the desert, which has heretofore claimed more than one victim. Before turning our faces toward Death Valley we proceed across the sloping plane to Bullfrog to replenish our food, overhaul our outfit, tighten water barrels, repair canteens, and arrange for forage which is to be hauled to us.

The towns of Bullfrog and Rhyolite are practically one, while Beatty is four miles east. The latter is situated on the Amargosa River, a small stream, but usually one has to dig to find it. I can give no figures as to population, for the inhabitants in most camps are a drifting lot—there may be many hundred, even a few thousand, one day, and soon afterward but a handful, as new strikes are made in outlying districts. At Bullfrog we find rendezvous camp which has been brought from Goldfield; as we pass up the street we find the omnipresent tent, a few adobes, and one house built of beer bottles set in mud. (These materials are the only inexpensive ones to be had.) At the head of the street rises Busch Mountain, one of the many peaks surrounding the camp, its sides scarred with the waste from prospect holes. One of our first experiences is to take a swim in a tank of goodly proportions fed by clear green water brought many miles in pipes. It is useless to try to express the joy and delight which comes in sporting and romping in the water, while parched bodies absorb the fluid until we are exhilarated as by a strong stimulant. It is our first wetting in—I blush to say how long! At Beatty we find a modern hotel with a wonderful variety of refreshment, solid and fluid, served to a nicety, including hammered-brass finger bowls, by men in conventional black evening clothes.

We look southward across the Amargosa Desert, stretching farther and farther until lost in the blue and amber of miles of heat with glittering sand and mud flats, flanked by the Bare and the Grapevine ranges, with the high peaks of the Funeral Range appearing beyond.

From Bullfrog the route lies across an extension of the Amargosa Desert to the Grapevine Range, to reach which we pass from arid Nevada into California, which here is hardly so luxuriant in foliage as its reputation might lead a stranger to anticipate, and at a boundary-line post set up for work.

THE DEATH VALLEY.

Twelve miles southwest camp is made at the Daylight Springs, on the crest of the divide between the Amargosa Desert and Death Valley. We journey to one of the high peaks of the Grapevine and look into the "Valley of the Shadow of Death," as desolate a view as may be found.

In the distance the Telescope Range rises to an elevation of nearly 11,000 feet, while at our feet the salt-white plain is more than 6,000 feet below us and well below sea-level. The flat is 25 miles away, and on its borders not a vestige of vegetation appears. The valley was named Death Valley from the loss of members of parties of emigrants who attempted to pass through it in 1849, and since then a number of persons has been lost, keeping up the sinister record as a graveyard, but the appalling stories of the number of persons perishing there each year are exaggerated. It is not safe to go into Death Valley for active work during July, August, and September, though there are persons who remain there all summer; but in October we journey from Daylight Spring down hill, mile upon mile. A sign painted upon a box lid stuck into a pile of stones gives us the cheerful assurance that we may be well provided for if we are found; it reads: "Rhyolite Undertaking Company, funeral directors and embalmers."

The canyon walls rise above us, not high, but sharp and steep, and it is only by turning and looking backward that we appreciate the greatness of the range we have crossed. The grade is easy, the road wide, sandy and gravelly, our horses grow weary and move with deliberation; all are oppressed with the feeling of weariness and lassitude.

We ride from the canyon mouth to the edge of a sandy plain, and here, 115 feet below sea-level, find a couple of holes, 5 feet in diameter and about as deep, with two feet of water in them. This is the "Stovepipe" Spring, so named from the fact that it was long marked by a section or two of that useful flue, placed upright, to inform the wayfarer where to dig when the holes had been filled by drifting sands hurled forward by the furious gales, burying deeper and deeper all vestiges of the water so necessary to life itself. We are indeed in *the* Valley; around us the sand drifts in little sheets; here and there a surface of broken and ragged saline material, hard and as rough as though made of giant saws set with teeth edge up.

We turn to the eastward; in the foreground the gritty beds of conglomerate and hard clays show as low hills backed by the ragged cliffs of the Grapevine, banded, rugged and grim. To the northward the cliffs and peaks guard this valley of desolation, the long delta fans of drift material spreading like great hands from the mouth of each canyon, burying from sight all vestige of the underlying rock, each a silent witness of the cloudbursts, which sometimes come roaring down the rock-bound clefts, to spread and evaporate like magic in the fierce rays of the sun. The farthest fan marks the mouth of Titus Canyon, named for the young Coloradan who left Bullfrog about the time we reached Goldfield, and perished in its lower reaches seeking life, as attested by the message penciled upon a sliver of stick broken from a provision box and left sticking in the sand for the guidance of his companion: "Have gone down canyon looking for the spring; have been waiting for you.—Titus." His remains were found; those of the friend are still resting undiscovered.

Across the flat we journey, our light vehicle loaded to its limit with food, forage, and water, the mules weary before starting.

Dunes surround us, 20 to 30 feet high, representing the struggle of plant life to keep its branches above the accumulating drift and its roots near enough water. The victory is eventually with the sand, into which wheels and hoofs sink nearly a foot, or when a harder surface is found it breaks like crusted snow, letting the beasts into a soft substance which they dislike exceedingly. Through such ground we can move but a few yards without stopping.

In places great bowlders obstruct the trail, among them the wagon must twist and turn through the fickle and shifting sands which often hide all signs of previous travel.

About 25 miles southward from the Stovepipe Spring, Furnace Creek flows from the lower part of a large wash which heads in the Grapevine Range. Here is one of the properties of the Pacific Coast Borax Company, which years ago constructed small irrigating ditches, sowed hay and planted trees, built houses, and established a plant for the treatment of the salts in the flat near by.

At 225 feet below sea-level are about 100 acres of emerald-like fields, long rows of fig trees, and abundant running water, while behind the frowning cliffs and sharp peaks of the Funeral Range guard the valley from the advance of the treasure-hunter from the east.

The borax plant is now idle, though the valuable beds are still owned by the company, which maintains a resident superintendent or foreman. The white flat which we saw from the mountain is composed largely of salt,* borax, and gypsum. The surface is as rough

* Chloride sodium	94.54
Chloride potassium	0.31
Sulphate sodium	3.53
Sulphate calcium	0.79
Moisture	0.14
Gypsum and clay	0.50
Total	99.81

—United States Geological Survey Bulletin 200, page 18.

as can be imagined; it consists of ridges, blocks, and plates on edge, inclined, and flat, with shallow drains full of dreadfully salt water. From these drains the mixture of salt and other material is taken, molded into forms, and set up at various places to mark the corners of the mineral claims. This material dries out, and, when the molds are removed, stands like solid marble blocks, which remind one of the fate of Lot's wife. Here we are informed that during the summer the temperature reaches more than 130 degrees in the shade, and that the nights are too hot for sleeping, but during our visit in November the weather was beautiful except during the fierce sandstorms.

Much of the real development in Death Valley has been done by the parties interested in borax, which is found here and in many parts of the desert region. The "cotton-ball" (borate of soda) is found in the flats, but "colemanite" (borate of lime) is found in the hills and mountains, high above the flats of the valley bottoms. At one time it was attempted to refine borax at Furnace Creek, but no work of gathering or treating is now done there. The freight teams of the company bring provisions every few months. From here the now-famous twenty-mule team hauled to Mojave; such teams are often seen along the lines of communication in the desert, but few have so many animals or such heavy wagons.

There is one way to become famous in Death Valley—that is, to die near to a trail so that one's remains may be found. For instance, meeting a man one day, I inquired about the route, water, etc. He said: "The road is plain for ten miles, when you'll find a well about 100 yards to the right; the water is salt, but your mules will drink it. Six miles farther you'll come to 'Tim Ryan, Aug. 9th, '05,' and two and one-half miles southeast of him you'll find plenty of good water."

From the valley where, even now in November, the temperature is between 80 and 90 during the day, we cross to the Panamint Range. At the mouth of Cottonwood Canyon we halt for lunch, having covered eight miles during the morning, and find numerous hieroglyphics on the walls. These illustrate Indians fighting over water, and depict a running stream, the bighorn sheep, and various animals and birds.

Twelve miles up this wash we find cottonwood trees, some grass, a running stream, and quantities of watercress, which the mules attack with evident relish. Here we find numerous prospectors, learn of an abandoned camp to the north, and water and trails everywhere.

In the Grapevine and Panamint ranges there are still a few mountain sheep. Tracks near water-holes and a few old skulls are the nearest we come to a view of these shy animals.

To the northward we follow along the range, often in sight of our valley camp miles away, and 48 hours after leaving the summit of the valley we are camping 9,000 feet above it, wading in snow varying from ankle to waist deep, with shoes and stockings frozen hard, the thermometer near zero, and a cruel wind—a most trying change for man and beast.

In the Panamint Range both sedimentary and volcanic rocks appear, and near one of the contacts of these we travel up a wonderful canyon. The walls are so near to one another that on horseback one may touch both at once. The material is limestone that has been baked into marble of alternate beds of black and white, about a foot in thickness. This trail is one of the old Indian routes to the Valley from Keeler and the Sierra Nevada.

From the summits of the Panamint Range we look into the Panamint Valley. Similar to Death Valley in form, but a little higher in elevation, the floor is 6,000 feet below the mountain tops and about 1,000 feet above sea.

Death Valley is by no means the driest of the regions traversed, but the heat and heretofore the inaccessibility have made it difficult. In the mountains flanking it are numerous springs and frequent waterholes which, though dry in summer through excessive evaporation, are available during the fall and winter. There are many springs that are credited as poison water; one of these we sampled, but unfortunately the bottles were broken before analysis could be made. In my opinion, there are springs in which arsenic is present, but most cases of sickness or death are probably due to drinking excessive quantities at one time, followed by physical exertion in the heat. Such springs as the Indians will not use are better left alone or used in extreme moderation, by no means an easy thing for one throat-parched and speechless for need of water. Each spring is a source of supply for flocks of birds, many of which are very tame.

The desert region is being rapidly invaded by the various transportation companies, replacing the primitive methods. The Tonopah and Tidewater Railroad is building from Ludlow, on the Santa Fé Railroad, through the Amargosa Desert, to the mines at Bullfrog, with connections to the borax mines *en route*. The railway from Las Vegas, on the San Pedro Railroad, to Bullfrog is under construction. These roads plan to run through to Tonopah, which will make prospecting much easier and less expensive, give a stimulus to the production and shipment of ores, and make profitable properties that would be practically valueless without them; they will lessen to a great extent the difficulties of travel. With these and other changes the desert will repay many fold those who seek its treasures of gold, silver, and lesser metals and materials.

The traveler in the deserts should be sound in heart, kidneys, and liver; have calm judgment; obtain all information possible of watering places before undertaking a journey; never leave camp without some food and water; discount from 30 per cent to 50 per cent the physical efficiency of himself and his animals, as experienced in other, cooler, fields, and abstain from alcoholic drinks, especially when doing physical labor. Many cases of collapse and death are due to alcohol or overestimation of strength.

Great mountains are a joy to the lover of nature; they are an inspiration to the artist, and express grandeur and nobility. The desert has no such spirit, but has a wonderful fascination, born of the impressiveness of magnificent distance, limitless sky, and the infinite patience of an unbreakable calm.

THE ONDAMETER OR ELECTRIC WAVE METER.*

By A. FREDERICK COLLINS.

IN the management of wireless telegraph stations where open and closed oscillation circuits are compounded to form coupled systems for the efficient radiation of electric waves from an aerial wire, it is often necessary to determine with precision the frequency of the surging oscillations and the length of the emitted waves.

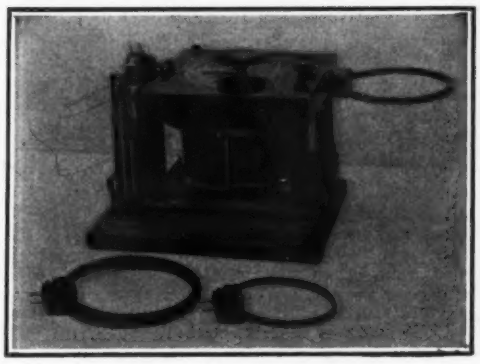


FIG. 1.—ONDAMETER.

There are a number of methods by which such determinations can be accomplished and various manufacturers of wireless apparatus have provided different instruments for these purposes. The device under consideration, called an ondameter, is the product of the Telefunken Wireless Telegraph Company of Germany and is based upon principles of resonance discovered by Heinrich Hertz and improved upon by V. Bjerknes, who was enabled to determine the frequency of oscillations by means of a modified form of a Hertz resonator tuned to the oscillator, but instead of the minute spark-gap employed by Hertz, one side of an electrometer was connected with the wire detector. J. Zenneck was the first to utilize this simple arrangement in the practice of wireless telegraphy, and later J. Dönitz further improved upon it when it began to assume some of the characteristics of an instrument of precision and has since been known as Dönitz's ondameter.

In construction the ondameter, or wave meter, shown photographically in Fig. 1, comprises a closed oscillation circuit made up of an inductance coil, of which three sizes are furnished, and a variable condenser. Each of the inductance coils has a fixed value, but the electrical dimensions of each are so proportioned that measurements of waves ranging from approximately 100 to 1,000 meters can be made by merely interchanging the coils. The condenser by varying the position of the plates may be given values of capacity within wide limits.

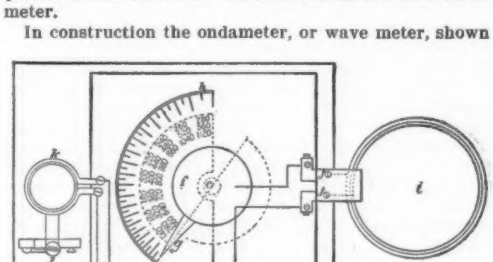


FIG. 2.

Fig. 2 shows the plan of the ondameter and Fig. 3 its elevation. Referring to these it will be observed that the ranges of capacity are not obtained in steps but in constant progression, since the condenser is formed of two sets of semicircular plates that are arranged parallel with each other, one set, *a*, being stationary, and the other and oppositely disposed set, *b*, being movable on the axis *c*. Both sets are mutually insulated from each other while, as in an ordinary condenser, the component plates of each set are joined together and connected with the terminals *d* and *e*.

It is evident that by turning the milled screw *f* the rotating members of the condenser will be brought into inductive relation with the stationary plates when the capacity—in virtue of the greater amount of available surface presented—is gradually increased. A pointer *g* is attached to the screw *f* and traverses a scale *h* on which is marked in three rows, corresponding to the three inductance coils, the wave lengths that have been previously deduced and which at the time the measurement is made indicates the wave length of the circuit measured. The plates of the condenser are immersed in boiled vaseline oil, since boiling removes the air bubbles, and this not only serves to provide a better insulation than air but also increases the capacity, for, as is well known, the dielectric constant of oil considerably exceeds that of air. The inductance coil *i* is connected to the terminals *j j* by inserting the plug ends into holes made to receive them, and this with the condenser forms a closed oscillation circuit through a small primary coil *k* shown in the diagram, Fig. 4; a small secondary coil connected to a Reiss hot-wire thermometer, *l*, places the latter in inductive association with the closed oscillation circuit of the instrument. The reason a small transformer is used instead of a direct coupling is to permit the energy impressed upon the thermometer to be regulated, which may be done by varying the distance between the primary and secondary windings.

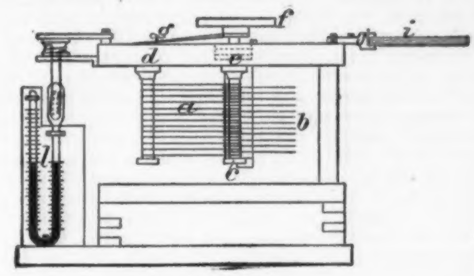


FIG. 3.

When the ondameter is connected inductively through the medium of its inductance coil which serves as the secondary, the primary being supplied by a similar coil connected to an oscillation circuit, either closed, as shown in Fig. 4, or open, as shown in Fig. 5, the thermometer gives the highest reading when the instrument and the circuit to be measured are in absolute resonance, as then the same frequency of oscillation is present in both systems. The heating effect produced by the current on the hot wire is indicated by the thermometer and is proportional to the squares of the current intensities, but instead of having to revert to calculation to determine the wave length the latter readings are made directly from the scale.

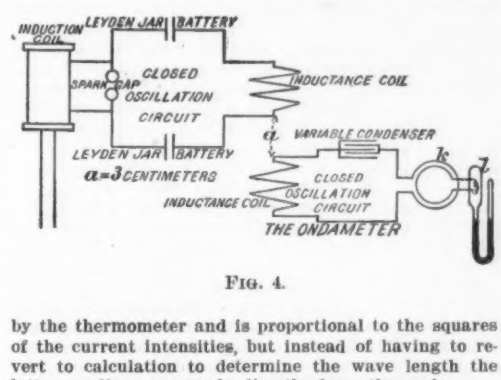


FIG. 4.

To measure the wave length of a closed oscillation circuit of a transmitter.—The ondameter and closed circuit of the transmitter are arranged as shown in Fig. 5. The primary coil of the closed sending circuit is placed parallel to the inductance or secondary coil of the instrument so that the latter is in the magnetic field of the former. For wave lengths from 140 to 280 feet the smallest coil is used, from 280 to 560 feet the intermediate coil, and from 560 to 1,120 feet the largest coil. Having chosen the proper coil from the wave length to be measured and having completed the preliminary arrangements, the screw of the condenser is turned until the thermometer shows that the maximum current is flowing in the closed circuit of the instrument; when this point is reached the resonance in the circuits is greatest and the actual length of the wave is shown by the pointer on the scale.

The exact distance between the magnetically inductive primary and secondary coils is not an essential factor, though these must not be so widely separated that accuracy is sacrificed nor yet so closely together that the oscillations set up in the secondary circuit of the instrument will react on the energizing oscillation circuit of the transmitter. If care is not exercised in

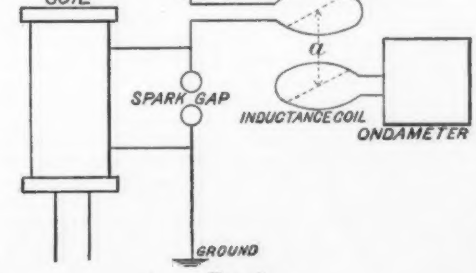


FIG. 5.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

this direction there will occur a deformation of oscillation. The optimum degree of coupling, that is, the distance between the two coils that gives the best result, is about 3 centimeters. In closed circuits where the oscillations are not rapidly damped out the thermometer will naturally give different indications, but a mean taken for the various amplitudes will approximate very closely the effective wave length.

To measure the wave length of an open oscillation circuit of a transmitter.—The ondameter is connected to a coil inserted in the aerial wire as shown in Fig. 5. As in the case of the closed circuit when oscillations surge through the aerial wire system it sets up similar high frequency currents in the resonating system of the ondameter; the proper value of capacity is then found by turning the screw of the condenser, when the thermometer will give the highest reading; the scale is consulted and the wave length read in meters direct.

The ondameter provides a very simple method for the amateur or professional to obtain accurate determinations and direct readings of wave lengths, of resonance between two oscillation circuits and the frequency of oscillations of direct and inductively coupled wireless telegraph systems.

[Concluded from Supplement No. 1630, page 26115.]

LIGHT AND ILLUMINATION.*

By Charles P. Steinmetz.

III.

After all, however, it is not light that is wanted, but illumination; it is not the amount of visible rays issuing from the source of light, the incandescent lamp or gas flame, which is of importance, but the amount of light which reaches the objects desired to be seen, that is, the illumination produced by the light. In this respect, a mistake has been made for many years, by the gas industry as well as the electric-lighting industry, by devoting all energy to the production of light—to the development of the lamp—while it was left almost entirely out of consideration that the production of an efficient light is not the only important problem, but of equal importance is the arrangement of the light so as to get efficient illumination, that is to get the greatest benefit from the light produced. This feature has been usually left to the tender mercies of the architect or the decorator, who placed the lights wherever he thought they would look artistic. Everywhere there are cases of artificial illumination where the lamps have been arranged so that they give a very poor illumination from a large amount of light. It is the object of this society to overcome these defects, to study the problems involved between the production of light and the physiological effec produced by the light on the eye, and it requires as careful study as any other engineering problem. It is of importance to consider, not only the amount of light issuing from the flame, but the amount of light which reaches objects to be seen by the illumination.

The demands of illumination are mainly of two classes, general illumination and local or concentrated illumination. Many places require general illumination, as a meeting room, where it is desired to see equally well everywhere, that is, to get the same intensity of illumination throughout the whole illuminated area. This is also the case in a drafting room, a school room, the hall of a house and the streets of a city. A uniform fairly high intensity is needed in a drafting room or school room, an intensity relatively low but as nearly as possible uniform in the streets of a city. It is true, street lighting is usually very far from uniform, but that merely means that the problem of proper street lighting is usually not solved in the most efficient and satisfactory manner. In other cases concentrated lighting is required, as, in domestic lighting, in the dining room, the living room, etc., where light is desired on the table for working, eating, or reading. In such cases, the general illumination of the room is of lesser importance, and is not needed to any extent, or is frequently undesirable, because a room with a very low intensity of general illumination frequently is considered more homelike, especially by the feminine part of the human race. In still other places general illumination may be directly objectionable, as in a sick room. Most cases, however, require a general illumination of moderate intensity, and a far more intense local illumination, as over the desks in an office, or the reading tables in a library. In such cases merely a general illumination would be sufficient if very intense, but this is uneconomical and to some extent objectionable on account of the blinding glare, which is disagreeable. Therefore a combined general and local illumination is more efficient and more satisfactory.

In producing illumination either direct lighting or indirect lighting may be used. That is, the rays issuing from the source of light may pass either directly to the illuminated objects, or they may pass to a reflecting surface, and be reflected from this surface to the object, or they may pass through a refracting body, as the frosted incandescent lamp globe, or the opal globe of the arc lamp, and so reach the illuminated object. In general, it is obvious that any method of indirect lighting by refraction or reflection wastes a considerable amount of light. That means, the total amount of light which reaches the illuminated object must necessarily be less with indirect lighting, as compared with direct lighting, with the same total amount of light.

Indirect lighting can be done by reflection or refraction by some attachment to the lamp, as a reflector or a Holophane or frosted globe, or by reflecting the light from the ceilings and walls of the room on the objects to be illuminated. In the latter case it is obvious that white walls give the highest efficiency of reflected light. It is easy to observe that the same source of light in a room with white walls gives several times the intensity of illumination which it gives in a room with black or non-reflecting walls. That means the total amount of illumination is increased several-fold by reflection from white walls. In a drafting room or schoolroom, the best efficiency of illumination may be got by using as light walls as possible.

It is not always feasible to have light walls, especially in machine shops or foundries, and other places where the walls do not remain white, but change to some darker color. The color of almost everything which is changed by age is due to either iron or carbon. In most cases of discoloration by age the reddish-brown color of iron and the brownish-yellow color of carbon are seen. This is the color most objects gradually assume. This color of age is in the long wave or low frequency end of the spectrum. To get the benefit of reflected light from walls which cannot be kept perfectly white, a source of light rich in the long low frequency waves or of a yellowish tinge is therefore more efficient as it gives more reflection from the walls than a source of light rich in short or high frequency waves such as bluish-white. This effect is very marked when the mercury arc lamp is compared with the flame carbon lamp. The illumination given by the mercury arc lamp in a drafting room is very satisfactory, but the same illumination in a foundry or machine shop is far less satisfactory, because of the marked absence of reflected light. Even the black-begrimed walls of a blacksmith shop reflect a considerable amount of light with an orange-yellow source of light, but reflect practically none of the bluish-green light of the mercury lamp.

Thus the shade of color of the illuminant may be very essential in getting efficient illumination. In the interior of a city, the walls usually have a reddish-yellow color. In that case white or yellowish lights are superior. Outside of the city the greenish-yellow light of the Welsbach lamp and the bluish-green of the mercury arc, give much larger amounts of reflected light from vegetation than do the yellow of the incandescent lamp and a better illumination results. Vegetation absorbs the long waves, the low-frequency radiation, so that with a yellow source of light there is practically no reflection from living vegetation. On the other hand, there is reflection of the long waves from dead vegetation, and in the light of the incandescent lamp or the flame arc all vegetation appears very poorly, because the dead parts are brought out prominently. The reverse is the case where the light is deficient in the red and yellow, and rich in the green and blue; the green shows prominently, but the dead leaves are not visible.

IV.

It is, however, not the amount of light which reaches the illuminated objects; that is to say, the physical intensity of illumination, which is of importance, but the amount of light from these illuminated objects which reaches the eye. With a given intensity of illumination, the amount of light entering the eye will vary widely with the opening or contraction of the pupil of the eye. The eye automatically adjusts itself to intensity of the light. This is the reason one sees well in sunlight and in the light of the full moon, although the former is many thousand times more intense than the latter. The eye can accommodate itself to intensities varying over an enormous range. It does this partly by the fatigue of the nerves of vision, and partly by the contraction or opening of the pupil. This is undoubtedly a protective device. It follows that if there is in the field of vision a source of high intrinsic brilliancy, the eye protects itself by contracting the pupil and thus receives much less light than it would if the source of light were taken out of the field. By eliminating the source of light from the field of vision and thereby eliminating the contraction of the pupils resulting from the high intrinsic brilliancy of the illuminating body, a larger amount of light is actually sent into the eye, although only the same amount of light strikes the illuminated object; that is to say, a higher physiological efficiency is obtained. Even though a much less amount of light reaches the illuminated objects, more light may reach the eye. That means that the intrinsic brilliancy of the illuminant may be reduced by indirect lighting or by diffusing the light, and thus a considerable amount of light may be lost, yet a larger amount of light enters the eye.

It follows from this that in efficient illumination, it is of the greatest importance to arrange the illuminant so as not to have excessive an intrinsic brilliancy in the field of vision. The proper place for the illuminant is outside of the field of vision. Where it can not be so put, its intrinsic brilliancy should be reduced by diffusion. This is the reason for indirect lighting. Even though a large amount of light is thrown on any object in a room, if the eye is fatigued by seeing the source of light, very little light will enter it.

It appears, however, that this automatic protective faculty of the eye was developed through the ages as a protection, not against light, but against energy; apparently the eye is protecting itself against the energy of the radiation, and not against the physiological effect, and since the energy of radiation is mainly in the ultra-red, in the long waves, the frequencies which cause the protective reaction are those of the long wave end of the spectrum, the red and yellow; they make the pupil contract. This action is much less for the green and the blue rays, which is the reason the eye does not react to the mercury lamp to any great extent. Therefore a green light, such as is given by the mercury or Welsbach lamp, may be placed more freely in the field of vision, without causing the contraction of the pupil and thus reducing the physiological effect. This is of importance in places where the light can not well be taken out of the field of vision, such as in street illumination. Here all the sources of light must be arranged along the street and so must be in the field of vision. By cutting off the red end of the spectrum the contraction of the pupil may be eliminated and the full benefit of the illumination between the lamps be obtained. It is otherwise with a yellow source of light, such as the incandescent or arc lamp. The physiological effect of the lighting by a green illuminant is, in such cases, superior to that by a yellow illuminant; the illumination appears brighter and more uniform.

A light devoid of red and yellow rays is at the same time the safest and the most harmful. It is the safest and gives the most uniform illumination, if its intrinsic brilliancy is sufficiently low to be below the danger limit of energy of radiation; but is harmful if above that, because the eye does not protect itself against it, probably because these lights have not existed throughout all the ages during which this protective action was being developed, when sunlight and fire were the only sources of light, both of which are rich in red rays. This accounts for the rather contradictory effect observed, that green or blue light, such as given by the Welsbach mantle or the mercury lamp, is a very good light to work by, superior even to the yellow kerosene lamp; and at the same time there is suspicion that it may be harmful to the eye. It may well be that when it is of very high intensity, the automatic action of the eye is not sufficient to protect it against such light. Where such sources of light are used, the benefit of the absence of the contraction of the pupil may be obtained, but the illumination must be arranged so as not to get the harmful effects against which the automatic protection of the eye fails. All of these blue and green lamps are superior for illumination if they have intrinsic brilliancies, but are somewhat questionable if they have extremely high intensities.

V.

It is, however, not even the actual amount of light which enters the eye which is of importance in illumination, but the differences in this light. If in the illuminated area the light is of uniform intensity, and everything of the same color, nothing but a glare of light will be seen. Seeing takes place by the recognition of differences in color and in intensity. Difference in intensity includes shadows. Shadows are thus an essential feature in seeing things.

Considering, then, the seeing by shadows and seeing by color differences, illumination may be divided into directed and diffused illumination. In diffused illumination light comes in all directions with approximate uniformity, and shadows do not exist; in directed illumination, shadows exist. In some cases shadows are objectionable. In others shadows are necessary for clear distinction, and diffused illumination in such cases would not be satisfactory.

Where definite color distinctions are required, the sharpness of vision may be intensified by selecting that color of light best suited to bring out the colors desired. Where the color conditions to be distinguished are those of age, due to iron and carbon, then that light which is deficient in red and yellow, and which, therefore, shows the colors given by iron and carbon as black, gives a much sharper distinction. The light of the mercury lamp makes blemishes and dirt much more pronounced than a white light. Again, the sources of light which are rich in red and yellow rays emphasize the colors due to iron and carbon less, and make less noticeable blemishes of a slight amount of dirt. Where the color distinctions are those due to these two most prominent elements, their appearance will be greatly softened in the yellow light. Under the green light they will be made harsh and sharp. If it is desired to soften effects, as in a ballroom, it would be fiendish to use mercury lamps, but where the object is to search out a spot that is soiled, it is wrong to use a dull yellow incandescent lamp or gas flame. Rather use the green Welsbach light, or better still the bluish-green mercury arc, which gives sharp distinction where white light shows little and yellow light nothing. Where it is desired to see all colors in about the same relation as by daylight, obviously a white light is necessary.

It is therefore important for the illuminating engineer, in selecting the shade or color of the light, to study the requirements of each case which comes into his charge. It would be just as wrong in one case to use an incandescent lamp, if the mercury lamp would be better, as to do the reverse.

It is necessary, therefore, to distinguish between general illumination and local illumination, between direct illumination and indirect illumination, and between directed illumination and diffused illumination. These three different classes or distinctions to a certain extent overlap. It would be wrong to mistake them, and a serious mistake in the design of a system of illumination can thus easily be made. For instance, general illumination and diffused illumination may be confused. The problem may be to get uniform intensity throughout a room. This may be done by dis-

* Read before the Illuminating Engineering Society and published in its Transactions.

tributing a large number of small units around the cornices and reflect the light from white walls and ceilings, thus getting a very diffused illumination. Or a general illumination may be obtained with the intensity of illumination everywhere the same in a moderate-sized room, from one source of light by using one source of light such as an incandescent lamp with a reflector which gives a uniform distribution. The former arrangement gives diffused light, the latter directed light. The intensity of illumination may be the same all over the room in both cases, but in the former case there are no shadows, and in the latter absolutely black shadows. Probably for domestic use lighting by the former method would be unsatisfactory and trying to the eyes, because, due to the lack of shadows, objects are not distinct. In the latter case with directed lighting from one source, the lighting will be unsatisfactory because of the very dark shadows in which nothing can be distinguished. The eyes are tired by trying to see in the shadows.

It is necessary to consider how much directed light and how much diffused light is required. In some cases only diffused light may be desired. In the general lighting of a drafting room directed light is not wanted, since there must be no shadows, because if the ruler casts a shadow, it is trying to the eyes to distinguish between the edge of the ruler and the edge of the shadow, and mistakes may be made. In this case, one sees only by differences in color and in intensity, and not by shadows. A satisfactory illumination is given by many small units or by indirect lighting by reflection from white walls and ceilings. An unsatisfactory illumination is obtained from a few units even when properly distributed to give uniform intensity all over, but giving little reflected light. In other cases a general illumination everywhere equal in intensity may be required, but directed illumination may be needed so as to see by the shadows. A good drafting room illumination would not be suitable for a foundry, where all the objects assume more or less the same color. Here shadows are necessary. What is needed is a number of units of light to get directed illumination. But this must not go so far as to make it impossible to see in the shadows. There must be some diffusion, or overlapping of the different beams of light. A satisfactory foundry illumination placed in the drafting room, even if the intensity were sufficient, would be entirely unsatisfactory, and so would be the reverse. It is, therefore, not merely the distribution of the intensity of the light which is essential, but also the character, whether diffused or directed light, or how divided between diffused and directed light.

In different lighting problems these questions of concentrated and general illumination, of directed and diffused illumination, are met. In domestic lighting a high intensity may be obtained by reflected light from white walls and ceilings. The illumination may be increased several fold over that given directly by the source of light, yet the illumination may be unsatisfactory and tiring to the eyes. In a home a room with white walls is not as agreeable as one with darker walls. There seems to be too much light. But there is not too much light, because there is not anywhere near the same amount of light as there is during the daytime out of doors. There is too large a percentage of diffused light. The intensity of the diffused light is too great as compared with the directed light. The shadows are lost and that is tiring to the eyes.

The problem of domestic lighting is to get sufficient directed and sufficiently low diffused lighting so as to give the best vision. That is, to get sufficient shadows to see by. But the shadows must not be so dark as to make seeing objects in the shadows themselves tiring to the eyes. During the daytime there is directed light from the windows and diffused light reflected from the walls. To get the proper proportion between directed and diffused light is what fixes the shade of the walls, and in general it is necessary to have the walls of somewhat darker color. But when lighting in the evening with a source of light like the incandescent lamp or the gas lamp, which sends out light in all directions, the diffused light as compared with the concentrated or directed light is greater than in the daytime for the colored walls, due partly to the color of the light, which is yellow and reflected more, but largely because the directed light coming through the window forms a much larger percentage of the total light than that of the lamp, where only a small part is concentrated light. It is not comfortable to have this strong diffused light, and therefore the walls are shaded so as to absorb three-quarters of the light. That means waste, however, and the light which is not used must be paid for. Proper illuminating engineering then is to secure the correct distribution of light so as to give the desired amount of concentrated lighting on the dining or reading table, and to give only as much diffused lighting as is compatible with the amount of direct light used. The problem of domestic lighting, from the illuminating engineering point, is to determine the proper illumination over the entire area, and also the character of illumination, whether directed or diffused, and how much of the light should be concentrated, and how much should be directed. Another important feature is the question of colors and shades as was discussed before.

Practically nothing has yet been done in this direction systematically and intelligently. Problems are solved by trial, which usually means producing more light than is necessary, and throwing away the excess of the diffused light by absorption.

EXPORTS OF MANUFACTURES FROM THE UNITED STATES FROM 1880 TO 1906.

"Exports of Manufactures from the United States and their Distribution, by Articles and Countries, 1800 to 1906," is the title of a monograph just issued by the Bureau of Statistics of the Department of Commerce and Labor. It shows that exports of manufactures from the United States now exceed 700 million dollars per annum and have doubled in value in a single decade. Not only has the exportation of manufactures doubled in a decade, but the share which products of the factory form of the total exports is steadily increasing. In 1880 manufactures formed but 15 per cent of the total exports of domestic products; in 1890 they formed 21 per cent; in 1900, 35 per cent; and in 1906, 40 per cent.

With the rapid increase of population in the United States, and therefore of the consumption of natural products, the quantity of food and raw materials remaining for distribution to other parts of the world has not increased proportionately; and with the development of manufacturing facilities and the trend of population to the manufacturing centers, production of manufactures has rapidly increased, and the surplus of these manufactures which may be spared for foreign markets has also increased. Foodstuffs, which in 1890 formed 42 per cent of the total exports of domestic products, formed in 1906 but 31 per cent of the total; articles in a crude condition for use in manufacturing, which in 1890 formed 36 per cent of the total, formed in 1906 but 29 per cent; while manufactures, as already indicated, increased their share in the exports from 21 per cent in 1890 to 40 per cent in 1906.

In the decade ending with 1905 exports of manufactures from the United States increased 198 per cent, while those from Germany increased 75 per cent, those from the United Kingdom 40 per cent, and those from France 25 per cent. This rapid increase in the exports of manufactures from the United States has brought her to the third rank in the list of the world's exporters of manufactures. The four greatest producers of manufactures for exportation and the value of manufactures exported by each of them in 1906 are as follows: The United Kingdom, 1,400 million dollars; Germany, 1,000 millions; the United States, 700 millions; and France, 500 millions. These figures, however, are approximate only, since the figures of the exports of the European countries are not yet at hand in sufficient detail to render possible an exact statement of the value of manufactures exported in that year.

The growth of the manufacturing industry in the United States has occurred chiefly in the last twenty-five years. Stated in round terms, the census figures of the gross value of manufactures in the United States are: For 1850, 1 billion dollars; 1860, 2 billions; 1870, 4 billions; 1880, 5 1-3 billions; 1890, 9 1-3 billions; 1900, 13 billions; 1905, 14 2-3 billions, the figures for 1905 being exclusive of neighborhood industries and hand trades included in previous years.

The increase in the production of manufactures in the United States, far in excess of home requirements, has forced our manufacturers to seek markets in other parts of the world for their surplus product. The result has been a rapid increase in the exportation of manufactures. The total value of manufactures exported from the United States has grown from less than 8 million dollars in 1820 to 23 million dollars in 1850, 48½ millions in 1860, 70 millions in 1870, 122 millions in 1880, 179 millions in 1890, and 485 millions in 1900, since which time the annual total has not fallen below the 400-million-dollar line, while in the calendar year 1906 the total exceeded 700 million dollars. In the fiscal year 1906, the latest period for which detailed figures of the exports by countries are available, the exports of manufactures were valued at 686 million dollars, of which 318 millions' worth went to Europe, 182 millions to North America, 64½ millions to South America, and 78¾ millions to Asia, while the remainder was divided between Oceania and Africa.

That this growth has been especially marked in recent years is shown by the fact that the actual increase by decades in exports of manufactures has been as follows: During the decade ending with 1830, 1.8 millions; 1840, 5.8 millions; 1850, 7.8 millions; 1860, 25.2 millions; 1870, 21.6 millions; 1880, 51.8 millions; 1890, 57.2 millions; 1900, 305.9 millions; and during the six years ending with 1906, 201.5 millions. Thus the growth of exports of manufactures in the sixteen years following 1890 was practically three times as great as that of the entire seventy years preceding that year.

COAL MINE GASES.*

By Richard Lee.

The principal gases met with in coal mines are carbon dioxide, carbon monoxide, carbureted hydrogen and after-damp. Carbon dioxide is formed principally by the combustion of illuminants, by the respiration of men and horses, and by the rotting of mine timbers. This gas is considerably heavier than air and tends to occupy the lowest part of the mine. It has a peculiar odor and taste but no color, and its presence is generally manifested by its influence on the flame of a candle, as it will not support combustion.

Experiments have shown that 15 per cent of carbon dioxide with air will extinguish the flame of a candle. It has also been proved that respiration may be maintained in a mixture containing 25 per cent of CO_2; this fact, however, should not encourage any one to remain in an atmosphere that will not support combustion, for after the light goes out there is no way to determine whether 15 per cent or 50 per cent of carbon dioxide is present.

When 50 per cent of this gas is present, the breathing is accompanied with considerable distress. If 60 per cent is present, the individual loses power over the limbs. This is also accompanied by confusion of the mind and the appearance of a heavy haze before the eyes, which is undoubtedly due to an insufficient percentage of oxygen to saturate the blood as it passes through the lungs. If fresh air or oxygen is now supplied the victim, the recovery is almost instantaneous, and no after effects are experienced from breathing the black damp.

Carbon Monoxide.—Carbon monoxide gas, generally known as white-damp, is not of such frequent occurrence in mines as black-damp. It is so poisonous that less than 0.5 per cent will produce giddiness; when it is present in a quantity exceeding 1 per cent, the result is generally fatal.

It has been found that 0.06 per cent of white-damp will visibly affect a mouse. This gas is generally known by its sweet odor and deadly results. Candles burn well when it is present, if anything the flame is brighter; when 13 or 14 per cent of the gas is present the flame is usually elongated.

When this gas saturates the blood to the extent of 50 per cent the individual loses all power over the limbs, so that it is almost impossible for him to escape. When the saturation of the blood reaches 80 per cent, consciousness is lost with no pain and little mental distress, and the victim passes away just as if a gentle anæsthetic had been administered.

Fire-Damp.—Light carbureted hydrogen, known as fire-damp, is the gas most commonly found in coal mines, and it is to this gas that explosions are principally due. Fire-damp is a mixture of several gases, and principally issues from the coal itself, where it is generally held in the pores or cells in a state of high tension.

It is disputed whether fire-damp can be detected by its smell. One thing, however, is true, that the greater the percentage of carbureted hydrogen contained in the gas, the harder it is to detect it by any odor. The gas if breathed for a considerable length of time would soon cause death; it quickly extinguishes the flame of a lamp if undiluted by air, but when found as it usually is in mine air, it can easily be detected by the elongation of the flame in a safety lamp. Experiments show that 7 per cent of this gas is explosive, and that when about 12 per cent is present, the explosion attains its maximum force; when 20 per cent of the gas is present it is no longer explosive and will instantly extinguish the flame of any lamp.

After-Damp.—After-damp is the product that results from the ignition and explosion of fire-damp and other mine gases. When 1 cubic foot of fire-damp is burned there are 40 cubic feet of air rendered unfit for respiration. After-damp is the most dangerous gas with which the miners come in contact, and it is now generally known that the majority of those killed in explosions have died from the effects of the after-damp which suffocated them.

Dr. Haldane, who made careful investigations at three different explosions, found that from 60 to 70 per cent of the bodies were neither burned nor injured, and that about 77 per cent might have escaped but for the effect of the after-damp.

Carbon monoxide, one of the deadly constituents of after-damp, cannot be detected by the safety lamp, as its action on the flame is almost unnoticeable. A mouse shows symptoms of poisoning from carbon monoxide twenty times quicker than a man, so that the little animal can often be used to detect a dangerous atmosphere. In a test of this sort it should be remembered that after-damp is lighter than air, so that the mouse must be kept as high above the head as possible.

When a miner has been rendered unconscious from the effect of after-damp, the best remedy is the prompt administration of pure oxygen, although this treatment is of no avail against the later symptoms which may occur long after the man has been removed from the mine. If breathing ceases, artificial respiration should be at once applied, and some authorities advise the use of weak stimulants to increase the heart action; this latter treatment is disputed, however, because of the shock the individual has already endured.

* From the Engineering and Mining Journal.

According to a notice in the German technical press, tests are being made on a large scale with a view to electrifying the Baden state railways. Current is to be supplied from a power station under construction at Wyhlen-Augst, where a turbine with an output of 1,500 horse-power is to be rented. It is calculated that an aggregate of 2,400,000 kilowatt hours will be required to supply the energy necessary for the electric operation. Three schemes have been suggested. That of the Siemens-Schuckert Works provides continuous current operation at 3,000 volts, with 40 ton, four-axle locomotives driven by 150 horse-power motors at two main speeds. The scheme of the Allgemeine Elektrizitäts-Gesellschaft provides single-phase current with three-axle locomotives at only one main speed. The former company estimate the cost of installation at 2,720,000 marks (about $680,000) and the working expenses at 331,087 marks (about $83,000), while the corresponding figures given by the Allgemeine Elektrizitäts-Gesellschaft are 2,281,000 and 349,700 marks (about $570,000 and $87,000) respectively. It may be said that the present cost of steam operation is 363,522 marks (over $90,000). It is expected that electric service will commence at the end of 1909.

THE NEW INLAND SEA.*

By ARTHUR P. DAVIS, Assistant Chief Engineer, U. S. Reclamation Service.

MANY centuries ago the Gulf of California extended to a point about 150 miles northwestward from its present head. It also extended up the present valley of the Colorado River at least to Yuma and probably somewhat above. The Colorado River, rising in the Wind River Mountains of Wyoming and the Rocky Mountains of Colorado, carved the rocks along its course and brought the resulting sands and mud down in its swift current, discharging them into the arm of the gulf near Yuma. As this process went on, without cessation, century after century, the valley was gradually filled, a delta built up, over which the river flowed far out into the gulf. It encroached progressively upon the shores of the gulf until it built up a delta entirely across, joining the foothills of the Cocopah Mountains on the western shore. This cut off the head of the gulf, and the arid climate rapidly evaporated the waters thus separated and left an inland depression, which at its lowest point was nearly 300 feet below sea level.†

The river continued to bring down its load of sediment and to build its delta higher and force it farther into the gulf. Like all such deltaic streams, the channel on the top of the delta is constantly shifting, cutting one bank, building up the other, overflowing both banks, and during high water sometimes entirely abandoning an old channel for a new one. In this way the river has from time to time flowed into the Salton Sea for some years or centuries, and anon has shifted to the eastward and discharged again into the gulf. This is the general course the river has followed ever since its discovery by the Spaniards in the sixteenth century. At high water the river normally overflows its banks in the valley regions all the way from the Grand Canyon to the Gulf of California. In unusually high water, such as occurred in 1891, the overflow running into the Salton Sink has been sufficient to materially raise the level of the lake and overflow the tracks of the Southern Pacific Railway, which are built along its shores.

THE IRRIGATING COMPANY RESPONSIBLE FOR THE BREAK.

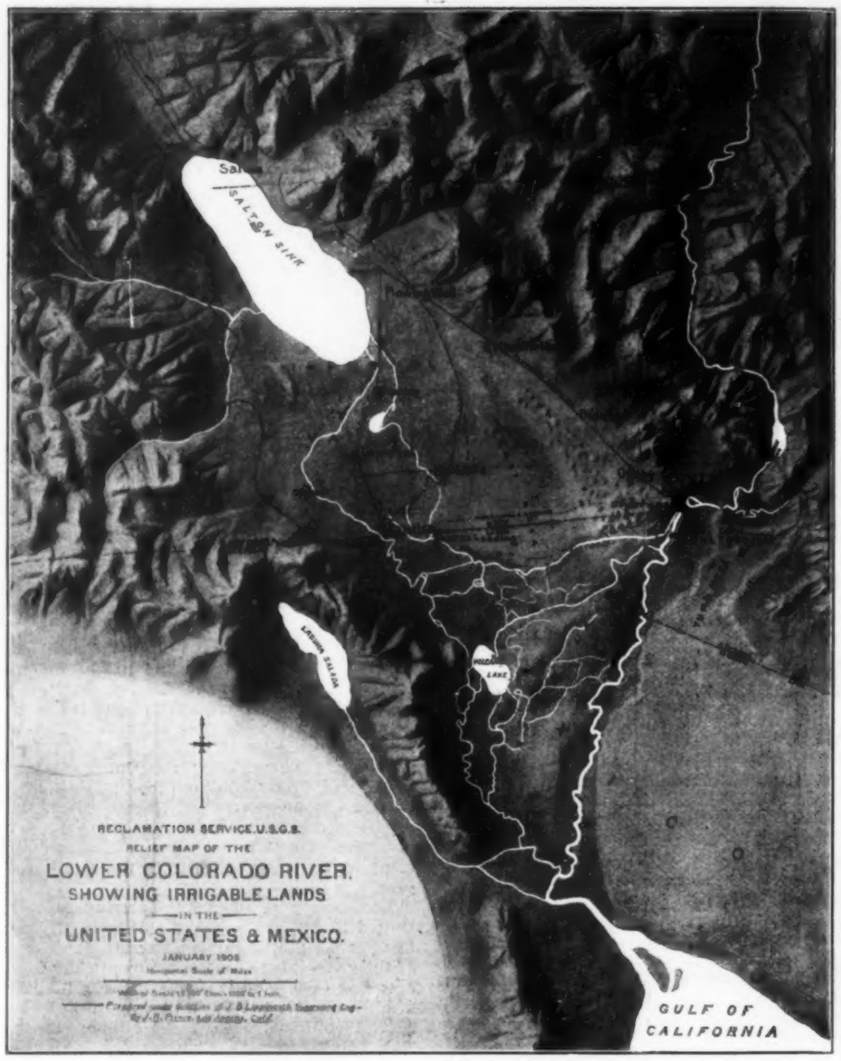
The ease of diverting the Colorado River near the international line and conducting the water through natural channels to the Colorado Desert for irrigation has been recognized for many years, and various attempts to promote this project have been made from time to time, usually, however, without success, owing to the international complications involved.

About 1891 Mr. C. R. Rockwood, a civil engineer, made plans for the construction of a headgate in rock at the foot of Pilot Knob, just north of the Mexican line, and of a canal to carry the water to the so-called Alamo River, an ancient channel of the Colorado which, by lapse of centuries, had been nearly filled with sand and sediment. Efforts to promote this project were for nearly ten years unsuccessful, but finally a small amount of money was raised, which, however, was insufficient for the construction of the works as planned. The promoters then concluded simply to cut the dirt banks of the river and lead the water by a small canal into an old channel, whence it flowed into the Imperial Valley without additional construction. A cheap wooden headgate was built in the canal near the river and was for a time used in the control of the waters. The water was diverted from the Alamo channel at a point called Sharp's Heading, just below the Mexican line, in the southern edge of the Imperial Valley. The water was led by canals over the land to be irrigated and settlement began.

The headquarters of the irrigation company were established at a town called Calexico, adjoining the

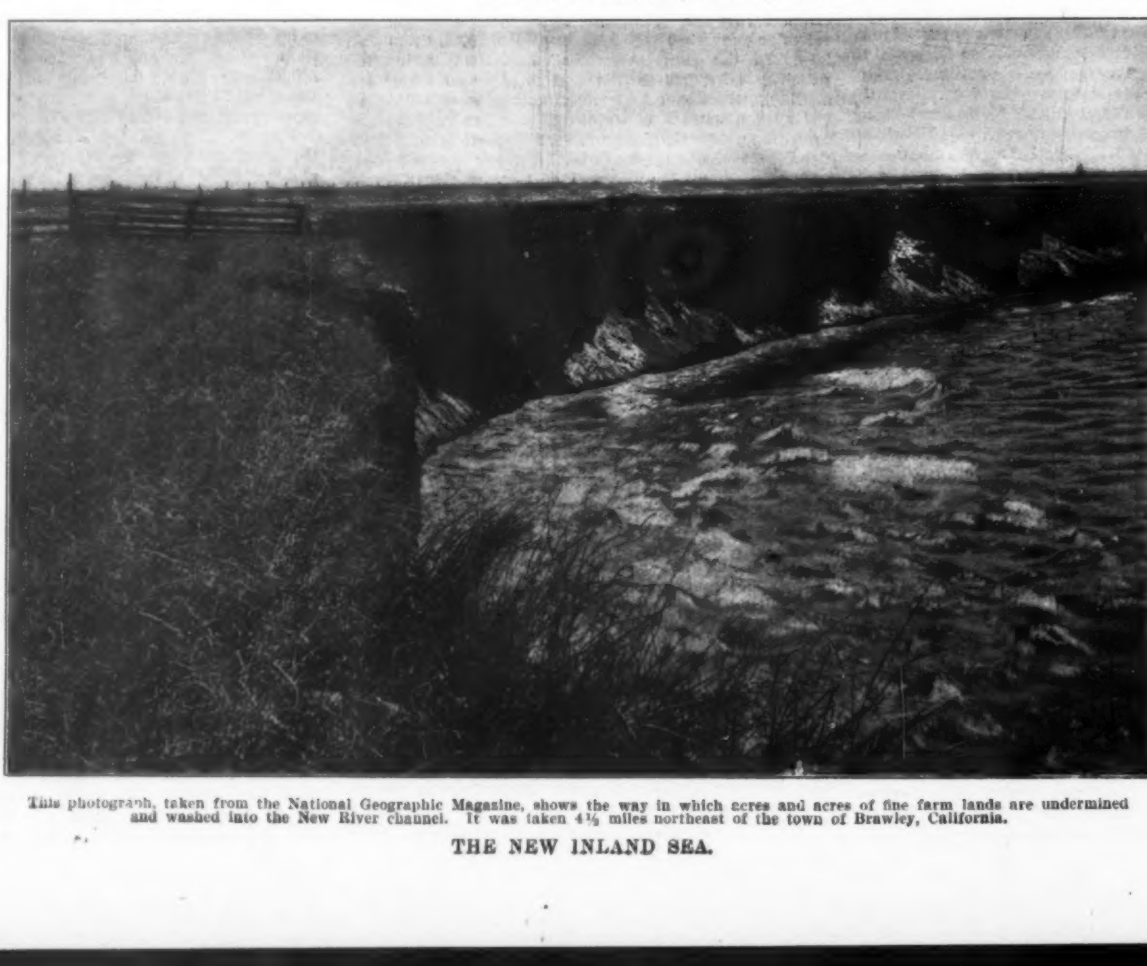
* An address to the National Geographic Society, published in the National Geographic Magazine.

† It is estimated that the amount of silt carried by the Lower Colorado River is sufficient to cover 53 square miles one foot deep with dry alluvial soil each year.



THE GREAT NEW LAKE RISING IN THE SALTON SINK.

The Colorado River is now flowing through the Imperial Canal into the Alamo River. Nine-tenths of the water leaves the Alamo River, however, at a point a few miles south of Sharp's Heading and rushes into the New River, and thence down into Salton Sink. Before this break occurred the Alamo and New Rivers were barely perceptible channels, filled with sand and sediment, and only occasionally carrying water. As the Salton Sink is nearly 300 feet below sea-level, the descending torrent has dug deep channels in the Alamo and New Rivers. These channels are preceded by huge cataracts, which are rapidly eating their way back and leaving the towns and canals without water. On November 4, 1906, a dam over 500 feet long was completed below Pilot Knob, which turned the river back into its old channel to the Gulf of California, but several weeks later the water worked its way around the dam, and the entire river is once more rushing down to the Salton Sink. The cataract in the New River is now rapidly approaching the Alamo, and if it once joins the Alamo, the Imperial Valley farms will be left high and dry until they are inundated by the rising Salton Lake.



This photograph, taken from the National Geographic Magazine, shows the way in which acres and acres of fine farm lands are undermined and washed into the New River channel. It was taken 4½ miles northeast of the town of Brawley, California.

THE NEW INLAND SEA.

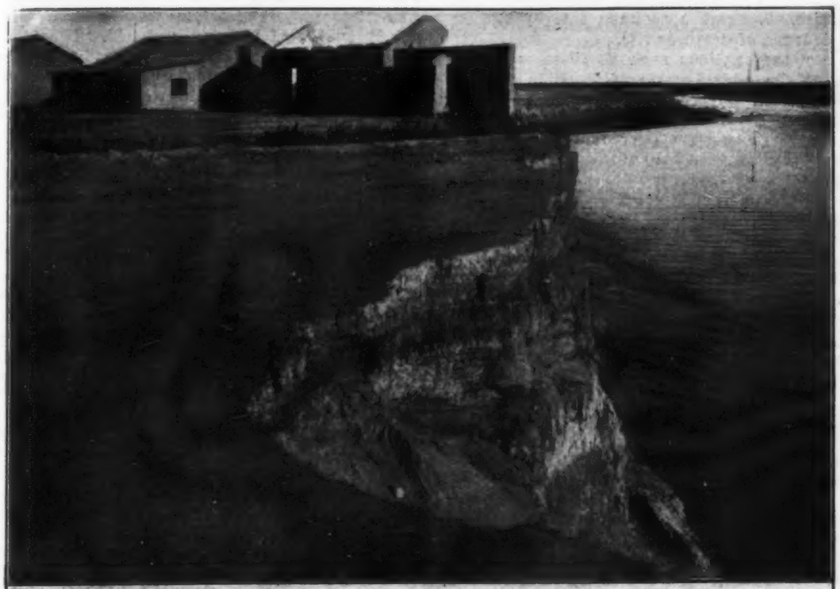
Mexican line, this name being derived by substituting the first syllable of the word "California" for the first letter of "Mexico." Settlers gradually came in and, the valley proving to be very fertile, development proceeded apace. As the demand for water became greater, however, the supply became less. The muddy waters of the Colorado River, checked by their entrance into the artificial channel, and still further checked by the obstruction of the headgate, deposited their load of mud, and constant effort was necessary to keep the heading open. The unsuccessful attempts to maintain the canal heading led to its abandonment and to the cutting of a new one near by in which no headgates were provided. This gave somewhat less trouble, but it, too, gradually began to fill and the effort at maintenance had to be continued. Several new headings were cut for the same reason, and serious losses occurred in the Imperial Valley from shortage of water during the time when most needed, owing to the difficulty of getting sufficient water into the head of the canal.

After repeated failures of the effort to maintain an open canal heading, the company finally went to a point about four miles below the Mexican line, where a greater declivity from the river bank could be obtained in a shorter distance, and there cut a large channel, with the idea of obtaining a sufficient velocity of water to prevent the deposit of sediment in the canal heading. In this respect the attempt proved successful, and throughout the low-water season of 1904-05, which occurs in winter, a large supply of water was furnished through this channel, sufficient for the irrigation of about 75,000 acres of land, most of which was under cultivation in the Imperial Valley. The Southern Pacific Railroad built a branch road from Old Beach through Brawley, Imperial, and Holtville to Calexico, and began building through Mexican territory from Calexico to Yuma, intending to make this the main line and cut out some heavy grades now encountered between Pilot Knob and Yuma.

THE BREAK OF JUNE, 1905.

The large new heading in Mexico maintained itself without silting throughout the low-water season, but when the annual flood of May arrived the larger volume of water and the consequent increase in velocity began cutting the channel, and in June it was found that the volume of water running toward the Imperial Valley was many times that required for irrigation and was rapidly cutting the channel wider and deeper. By the end of August, 1905, the majority of the water of the Colorado River was flowing toward the westward instead of the south, and the Salton Sea was rapidly rising and submerging portions of the Southern Pacific Railroad track, which were hurriedly moved to higher ground.

The distance from Yuma to the Gulf of California along the general course of the Colorado River is about seventy-five miles. The distance to the Salton Sea is not very much greater, but the difference in elevation between the gulf and the Salton Sea is about 280 feet. The gradient from Yuma to the gulf is about two feet per mile along the windings of the river, which is the natural gradient adopted by this river under the circumstances with which it is beset. The channel to the Salton Sea, therefore, had more than 200 feet surplus declivity, so that the water in running through that channel was rapidly eroding its bed. It cut the gorge wider and deeper near the Salton Sink and formed great falls or cataracts in the channel. The channels near the vicinity of Calexico had been so nearly obliterated with the lapse of time that the waters spread over a large area of the country, and as the quantity increased threatened to engulf the farms and the town of Calexico. Large dikes were hurriedly built to shut out the water, and the town was thus saved from disastrous inundation before the waters rose high enough to sweep it away. In the meantime channels formed near the Salton Sea, and were cutting deeper and deeper, the cataracts therein were advanc-



CUTTING WORK OF THE NEW RIVER.

This photograph, republished from the National Geographic Magazine, shows how the Mexican town called Mexicala was partly destroyed by the New River cutting into the town at this point.

Cut and washed banks in the big bend of the New River, 5 miles northwest of the town of Imperial, California. These banks are from 60 to 80 feet in height and are constantly caving into the river bed and washing away, consequently widening the river and cutting back onto the farm lands.

A few months ago this was fertile land cultivated by prosperous people. Looking down New River canyon from a point in big bend, 5 miles northwest of Imperial, California.—From the National Geographic Magazine.

THE NEW INLAND SEA.

ing upstream as the water undermined them and carried the debris into the sea. As these cataracts advanced upstream they left below them, of course, deep channels, which carried all the water far below the surface of the surrounding country to the Salton Sea. In the early part of the present year the cataract in New River had reached Calexico, after which, instead of threatening to overflow this town, the water was in a gorge 45 feet below the surrounding country. Opposite Imperial the channel of New River is over 80 feet in depth and that of the Alamo nearly as deep.

The large amount of water flowing down the Alamo River was rapidly eroding this channel throughout its course. Sharp's Heading is a cheap wooden structure and has been for some time in imminent danger of washing out, which would have left the canals of Imperial Valley without water for irrigation, though domestic water might have been obtained with great effort from the deep channels of the Alamo and New rivers.

(To be continued.)

[Concluded from SUPPLEMENT No. 1630, page 26119.]

THE ETHICS OF JAPAN.*

By BARON KENCHO SUYEMATSU, B.A., LL.M.

HERE I have to speak of Bushido. The term, as well as its general purport, has been of late made widely known in this country; but, as many people wish it, I will say something about it, although it may be only, as we say, "adding legs to the picture of a serpent"—I mean it may be quite an unnecessary addition. Bushi literally means a military gentleman or, in more common English, a military man, and "do" literally means a road or way, and in its extended significance, a principle, a teaching, or a doctrine. The term for "bushi" in old refined Japanese is "mononofu" and the term for "do" is "michi"; therefore the more refined ancient Japanese name for Bushido was Mononofu-no-Michi. The origin of the "bushi" is as follows: They were originally large or small landlords of the provincial parts of Japan, and had their retainers or vassals. At the time when, in the court of the Empire, over-refinement, or rather effeminacy, succeeded enlightenment, and nobles who usually resided in the capital came to despise military service, those landlords and their retainers began to play military rôles under different distinguished leaders. They were more prominent in the eastern parts of the country, called Kwanto, namely, the large plain, in the middle of which modern Tokyo is situated. With the march of events, when the governing power fell into the hands of the military leaders, these landlords and their retainers began to form an hereditary class, and the system extended to the whole country. This is the origin of Daimio and Samurai. I do not say that in the case of later developments of this system all Daimio and Samurai necessarily belonged to the same ancient stock, because at the time when the country went through many stages of war many new men appeared on the scene and enlisted themselves in the ranks of the Samurai, among them the bushi, several of whom became Daimios themselves by their personal valor and the distinction they attained. But I may say that, on the whole, the successive stages of the class always inherited and handed down the same sort of sentiments and notions as their predecessors.

We may, in a measure, compare this military class with the country squires in this country, who gradually became barons of the middle ages, together with their children and retainers. "Bushido" is no other than the doctrine held and cherished by that class as its code of honor and rule of discipline. In the earliest days of the development of that class individuals forming it were not cultured or enlightened in the sense of luxurious refinement; in other words, they were mostly illiterate. But, on the other hand, they were mostly men with healthy notions of manliness in contrast to those who usually lived in the capital town where literary and artistic culture under Chinese influence had been attained in a marked degree. The motive and sense of their culture were therefore more like those belonging to primitive Japan, unstained by foreign influences. The families belonging to this class were called in their early days "the houses of the bow and arrow." Needless to say that the early projectile weapons of warfare were the bow and arrow, and they had a place of honor among the warlike instruments of those days. Little by little a phrase "yumi-ya-no-michi," literally meaning "the ways of the bow and arrow," came into existence, and it was the original name of Bushido. At first, perhaps, the word referred more especially to the proper use of the instrument of war, but it soon came to signify something more. There were many ceremonies and etiquettes which grew up with a warrior's life and military affairs, not only with reference to his comrades or to his superiors and inferiors, but also with reference to how he should comport himself toward his enemy. At the bottom of all these matters there lay the idea of honor, not merely one's own honor, but also a compassionate regard for the honor of the enemy. All these ideas came to be implied in the term "the ways of the bow and arrow." Here we see that special moral sentiments were being awakened among this class. Bushido, however, has no particular dogma or canon, except such as grew from practice and except those of which we can gather some idea from instructions given by certain leaders or by certain teachers of military ceremonies or science in the way of interpretation of such matters. Here we have an instruction given to his men by Yoritomo, the first shogun, and therefore one of the early leaders of the system. The essential points of the instructions are these: 1. Practice and mature military arts. 2. Be not guilty of any base or rude conduct. 3. Be not cowardly or effeminate in behavior. 4. Be simple and frugal. 5. The master and servants should mutually respect their indebtedness. 6. Keep a promise. 7. Share a common fate by mutual bondage in defiance of death or life.

We may say that notions such as these were the foundations of the ethical parts of Bushido. These will mean when interpreted in ethical terms of the Chinese school: 1. Diligence in one's profession. 2. Love and loyalty between master and servants. 3. Decorum and propriety. 4. Gallantry and bravery. 5. Trustfulness and justice. 6. Simplicity and frugality. 7. Contempt of meanness.

At the bottom of these lay the sense of honor. When speaking of any action as unworthy of a bushi, the following phrase was customarily used in early days, "It is disgraceful in the presence of the hand of the bow and arrow," as in later days one would say "a disgrace to bushi," in the same way as you would say in English, "It is unbecoming to a gentleman." The term "bushi" has in many ways a similar meaning to "gentleman" in English. Bushido, of course, encouraged bravery above all things. In an old book describing the war between Gen and Hei, an account of the bravery of bushi of Kwanto—namely, the plain above referred to as that where Bushido originated—is put into the mouth of a general of Hei as having been addressed to his generalissimo, who commanded the army of Hei, which was formed of recruits coming from Kioto and its neighborhood. The narrative was to this effect: "According to the usage of the warriors of the East, the son would not withdraw from the battlefield, though his father might die, or the father would not think of retiring though his son might fall. He would advance and advance, and jumping over the dead, would fight regardless of death or life. As to our own men, they are all weakly recruits from the neighborhood of the capital (where effeminacy reigned at the time). If the father was wounded, the son and all the members of the family would take advantage of this and retire; if the master were killed, his followers would utilize the chance and, hand in hand with their brothers, would withdraw and disappear." This may be a somewhat exaggerated account, but it will show how greatly the original bushi estimated bravery in the same way as our men do in these days.

In addition to these characteristics some other features which were brought into more prominence are entitled to be singled out—namely, fortitude, generosity, imperturbability in the presence of danger or on any unexpected occurrence, compassionateness, and straightforwardness. This kind of attitude was inculcated even in physical exercises of different modes of fighting, such as fencing, practice with the spear, and jiu jitsu. There is a verse composed by a Japanese which may be translated thus:

> "Even in the eyes of the warrior
> Whose beard is ten fists long,
> The one thing that softly flows from them
> Is the tear which is due to love."

This aptly expresses the innate tenderness of heart of a Japanese warrior. There is another verse composed and penned by Commander Takeo Hirose in Chinese just before he went to his doom on the occasion of the second bottling up of Port Arthur, and which, therefore, constituted his last utterance in this world. Translated into English, it runs as follows:

> "Would that I could be born seven times
> And sacrifice my life for my country:
> Resolved to die, my mind is firm,
> And again expecting to win success,
> Smiling I go on board."

This will show the fortitude and determination of a bushi at the hour of his exit from this life, and though Hirose was a man of our own day, he may be regarded as one of the best types of an old bushi.

Bushi is not foreign to Shintoism. As a matter of fact, bushi generally respect Shinto deities, and, moreover, some military ceremonies were performed in the supposed presence of a Shinto god. Bushi openly invoke the god of war without any compunction, but bushi never have done so in a bigoted way. It was more in the way of reverence paid to a deity of their inherited cult. They were never devotees of Shintoism as a religion. This sort of sentiment of the Japanese is very difficult to explain with clearness, but my meaning is that though they do not despise religion they place more importance on the affairs of the world and on their own exertions in the matters which they undertake. The Samurai do not worship their deity in order that their souls may be safely rescued in the future. I can therefore say that Bushido, as such, has no bearing upon Shintoism. It has its own independent existence, although to the extent I have just referred to it has its connection with Shintoism. In other words, Shintoism was a cult founded upon our old customs and traditions, and therefore bushi also shared the sentiments pervading that cult, but we cannot say that Shinto has produced Bushido.

And again, bushi do not despise Buddhism; on the contrary, many of them may revere it, but Bushido, as such, has no connection with this faith. In documents they often make use of a phrase in a vague way, "by the help of Shin-Butsu," meaning both the Shinto deity and Buddha; but it does not mean that it has any foundation in Buddhism. If a bushi were a believer in Buddha he probably would not like to show it. We have a story about Yoritomo, the first head of the Shogunate. When he first started in his youth his campaign against Hei, and hid himself in a mountain nook, having been defeated by his enemy, he took out from his queue a small image of Kwanin (Kwannon) which he reverenced, saying, "If my head be taken by the enemy it would not be becoming to the generalissimo of Gen if this image were to be discovered." This will give you an idea of the way in which Buddha was viewed by bushi. As we all know, Buddhism chiefly speaks of the future world. The idea of the bushi was that it was an act of cowardice if one merely did good because one wished to be saved in the future world. Their idea was that good should be done for its own sake, and therefore if one believed in Buddha he had a sort of apprehension that he might be considered a coward. Of course history is not wanting in many instances of great warriors believing in Buddhism, but in many cases this fact had no great significance as far as their conduct and conscience were concerned. There was, however, one feature in which a certain aspect of Buddhism had a considerable influence in molding Bushido; it was the influence of the teaching of the Zen sect. This requires some explanation. In the thesis of Buddhistic teaching there is included the idea of absorbing everything in the universe into one's self; in other words, mental annihilation of all things except one's self. This is done by long and fixed meditation, and at least so far as he himself is concerned, a man can for the moment imagine and realize mentally that he is the only being in the universe, and all other things become nothing. Hence, when he is accustomed to meditation of that description, nothing will ever surprise or frighten him.

There is a story about Hieuntsang, the famous Chinese Buddhist of the Tan period, who visited India. This priest was once caught by a band of robbers. He sat quietly down and began to meditate in the way described above. The robbers tried to intimidate him by threatening him with drawn swords pushed right into his face; but the priest took no notice whatever of what they were doing to him, and remained entirely unmoved. The robbers, observing the attitude of the priest, and thinking that he must be an extraordinary personage, all went away and left him alone. This phase of Buddhism was introduced into China, where it became the cult of one separate sect of Buddhism. Bodhi-Dharma, an Indian priest, who visited China, is commonly accepted as the founder of this sect, which practises meditation more than do other sects, but of course meditation is not its only feature. In general, we may say it is more philosophical in the sense of regarding the universe in a nihilistic sense. This sect is called Zen, and it has been introduced into Japan also. It was patronized by several eminent bushi in its earlier stages. Perhaps it was liked by them in that, according to its doctrine, a man puts aside the idea of reliance upon another and places himself above everything else, and it was found to have an agreeable resemblance to the spirit of self-reliance inculcated in Bushido. In the second place, it repels all ideas of luxury and display and values simplicity and cleanliness, and in that respect it was found to bear an agreeable resemblance to the frugal and simple life of the bushi. Thus the Zen came to exercise its influence over the bushi, but not at all in the sense of believing in future felicity; quite to the contrary, from the very nature of that sect. This influence of Zen seems to have helped to a great extent the development of some of the characteristics of Bushido, such as imperturbability, stoicism, fortitude, and simplicity and cleanliness of thought or body. Here I may add that many traits of Bushido are no doubt to be found in the European knighthoods of former days, and therefore they are not really new to the Europeans who still remember those traditions.

The weakest point of Bushido in its earlier stages was its want of literary culture in the way of systematic ethical study, hence it easily happened that a thing one might regard as correct might not be correct in reality when examined from a higher point of view. This difficulty was especially observable when two obligations came into conflict, and one had to be preferred to the other. The bushi, in the earlier stages, knew more about their duty to their immediate master than to higher ones; hence their difficulty in discerning their duty to the supreme ruler of the land and their immediate head. Of course, they knew that the Emperor was the highest personage in the country, but they were unable to find out an ethical solution of the question, and, indeed, in all matters they wanted more systematic enlightenment.

These wants, however, have been supplied gradually as time went on, especially during the last three centuries. During this period almost unbroken peace reigned in the country. It ceased to have any intercourse with foreign countries except in a limited sense, but internally all branches of art and industry were encouraged and developed side by side. The study of Chinese and of native classics has been carried out in all parts of the land, and it was the bushi who chiefly devoted themselves to such culture. Bushi or samurai were retainers, as everyone knows, of their lords, and certain pensions were given by their lords to each family, according to their rank, so that they had not to work for their own living. Hence, their only duty was to make themselves physically and mentally fit to fight for their lords in time of necessity, and in times of peace to make themselves as much like gentlemen as possible. In other words physical training and mental enlightenment, together with the refinement of their manners and habits, were their sole business—they had no other occupation. For, indeed, any other occupation which partook of the shape of business conducted for profit was forbidden and was despised among them. Bushido came to be deeply imbued with the principles of Chinese and Japanese classics as they were taught.

* Reprinted from Journal of the Society of Arts, London.

I have shown above that in the systematic exposition of ethical ideas, Confucianism was the richest of all, and the essential part of it was taken by Bushido; as I have also shown above, there are many defects in the Chinese teaching; all the unimportant parts were cast away and the important parts were taken into the teaching of Bushido, and even these parts only in such a way as to suit our national traditions and characteristics, the essential spirit of Shintoism also being resuscitated in such a way as to give an impetus to Bushido, though in no orthodox manner. Such, then, is our Bushido. The bushi formed the governing class of the Japanese society, and it may be said the educated class also, or in other words the bushi may be called the gentry of the country. We can, therefore, say that Bushido was the ethics of Japanese society. In one way it may be said that Bushido, as such, was a monopoly of the military class, but in truth its spirit was not confined to this only; the literary study of Chinese, as well as of native classics, was not necessarily limited to the military class; hence the same notions which were imbued in it through these studies were also quietly extending their influence among people at large—among whom, I may add, there were many families of old bushi, or families which were quite equal in their standing to the bushi class. Moreover, the spirit of Bushido has also been making its influence felt by other people. Thus we can see that the nation has been preparing itself for centuries for the promotion of moral ideas of the same kind as those of Bushido.

The cardinal points of Oriental ethics, as may be expected, are loyalty and filial piety. In China filial piety takes precedence, but in Japan loyalty stands first. There is a poem by Sanetomo, the third shogun of Kamakura and second son of the first shogun, which may be translated literally as follows:

"The sea may dry up,
The mountain may burst asunder,
But no duplicity of thought
Shall I have to my sovereign."

Such is the idea of loyalty which has been taught to the Japanese for centuries. Side by side with loyalty the idea of patriotism—a term which in Japanese is almost identical in its purport with loyalty—was also inculcated, though the development of this last idea was later than the former. Then, also, all the other ideas relating to ethics, especially on the lines indicated in Confucianism, were inculcated side by side. With the abolition of the feudal system, some thirty years ago, the structure of Japanese society was totally changed, or rather restored to the condition which preceded the ascendancy of the military class in the twelfth century. The question now arises, What is the actual state of ethics in Japan at present? There is a new element which has been introduced into Japan in recent years, and it is in the form of Christianity. The constitution guarantees freedom of conscience, and therefore there is no hindrance to the propagation of the Christian doctrine with its moral teaching, and, as a matter of fact, there are a number of Japanese who have embraced that faith, but they are after all a very small minority compared with the number of the whole Japanese population. The essence of Japanese ethics is the same as existed prior to the new epoch, with certain modifications actuated by the new force of the altered conditions, which, after all, are only in small details. I may say, in a word, that the Japanese ideal ethics form an extension of Bushido among the people at large from the non-extinct class of bushi with whom it originated. As to how they stand at present and how they are inculcated among the people at the present time, I must refer my audience to an article entitled "Moral Teaching of Japan," which was contributed by me to the February number of The Nineteenth Century and After. The sphere of the teaching is extensive, as is necessary from the very nature of the matter, but its essence may be summed up in a comparatively small compass. For this I cannot do better than quote a part of the so-called "Imperial Educational Rescript" given to his people by the present Emperor. It is quoted in my article to which I have just referred, but I will recite it once more:

"It is our desire that you, our subjects, be filial to your parents and well disposed to your brothers and sisters. Let husband and wife dwell harmoniously together; let friends be mutually trustworthy. Impose upon yourselves self-restraint and rectitude of behavior. Extend to the multitude philanthropy. Advance learning and regulate your pursuits, developing the intellectual faculties and perfecting the virtuous and useful elements. Further seek to enhance the public good and enlighten the world by deeds of social benefit. Treasure always the fundamental constitution and respect the national laws. In any emergency exert yourselves in the public service and exhibit voluntarily your bravery in the cause of order. And by every means assist and promote the prosperity of the imperial régime, which is lasting as the heavens and the earth. Thus you will not only be our loyal subjects and good citizens, but will manifest the highest and best traditions of your ancestors."

Such, then, are the essential phases of the ethics of Japan. They may be far from reaching your lofty ideals and expectations, but we are contented with their general tendency, while at the same time we do not forget to inculcate the necessary furtherance and expansion of our ideas required by the changing circumstances of the time. We are likewise mindful of the desirability of carrying them out in such a way as not to conflict with the best ideals of any other country, for our sole aspiration is to preserve harmonious relations with the whole of mankind.

THE NOBILITY OF THE CHIN AND THE CANNIBALS OF KRAPINA.

According to a popular saying, blue blood is a sign of nobility. It is true that the blood of the Molucca crab forms a deep blue clot, owing to the presence of copper, and that this spike-tailed crustacean is one of the most ancient of crabs, and may therefore be said to enjoy an exalted rank in crustacean nobility, but not only is the blood of all human beings very much alike, but it is very much like the blood of other mammals. Only one mammal is distinguished from the rest by a strikingly different form of blood corpuscle, and that one is the meek and lowly camel. When the blood of different species is mixed together, the ingredients of the mixture may or may not destroy each other. Human blood kills the blood corpuscles of the lower monkeys, and monkey's blood kills the corpuscles of mammals lower in the scale, but this law is not absolute, and human pre-eminence cannot be based on it, for human blood and the blood of the chimpanzee live together in peace.

But the profile of the human face contains one line which is essentially human and characteristic, when strongly developed, of highly civilized humanity. This is the line of the chin. In a head that deserves the epithet "noble," a strong chin is, so to speak, a spiritual necessity, and even a woman's face loses its charm if it is destitute of a distinct chin. This is an old and approved canon of physiognomy, but it has only recently been discovered that the chin was not possessed by primitive man, and that it is consequently a patent of the highest nobility, that of culture.

In the sandstone wall of a ravine at Krapina, in Croatia, is a cave that was undoubtedly hollowed out ages ago by the stream that now flows eighty feet below. The rock floor of the cave was first covered with pebbles mingled with bones of beavers, and afterward the cave was gradually filled with fragments of stone that fell from the crumbling roof. In the course of this slow process, after the water had receded and before the hollow had been completely filled, the cave was visited successively by various creatures that have left evidences of their presence. At certain periods the cave was inhabited by bears, and the bones found buried in the débris prove that these bears were of the long extinct species known as the cave bear of the ice age. It is certain, too, that many generations of men occupied or visited the cave. Here they made fires, among the charred embers of which were found rude stone weapons, fashioned from the pebbles of the stream, together with bones of the mammoth, cave rhinoceros, deer, and wild horse.

One of these ancient ash heaps contained a great number of more grewsome objects—human bones that had evidently been roasted in the fire and crushed by heavy blows. From these and other evidences it is obvious that the bones are the refuse of a cannibal feast. At least ten men, women, and children were here devoured by creatures who built fires and possessed stone weapons and who, consequently, were not bears, but human beings. This catastrophe, like the destruction of Pompeii, has proved valuable to posterity, for it has preserved for many thousands of years the only certain evidence that we possess of the existence in Europe, during the glacial period, of a human species more ancient and less highly developed than our own. There are now on earth a great many distinct races of men, but all of these are included in one species, which is designated as *Homo sapiens*. But the victims of Krapina (and probably the cannibals also) belonged to a different species, which anthropologists now agree in designating as *Homo primigenius*. Earlier and much-discussed discoveries had pointed to the former existence of this primitive species of man, but all doubt has been dispelled by Prof. Kramberger's masterly description of these relics of Krapina.

These ancient "near-men" had long bodies and short legs, with massive thigh bones, curved forward. Their skulls were very thick, with heavy long ridges over the eyes and foreheads, receding almost horizontally, as in the celebrated Neanderthal skull that was so long the despair of anthropologists. In fact, there was no forehead in the usual meaning of the word, and the opposite pole of the face, the chin, was also lacking.

The total absence of a true chin must have been the most repulsive peculiarity, according to our ideas, of the faces of these men of Krapina. The lower jaw, instead of forming an angle, sloped sharply backward in the form of a snout. Yet the lower jaw was not smaller, but much larger, than that of the present human species. It was filled with large teeth, and must have been furnished with big and powerful muscles. These massive jaws evidently crunched bones as easily as ours chew bread crusts.

But, with all their size and strength, these jaws and teeth, like ours, were adapted essentially for chewing and not for fighting. There were no great tusks or canine teeth like those which serve the gorilla for attack and defense. Hence even this primitive human species must long have been in possession of artificial weapons. Nor is any close resemblance to the gorilla indicated by the nose or by the eye sockets, which are as far apart as our own. Yet the face of the Krapina man must have been far more brutish than that of any human being now living.

If we assume that we, as members of the species *Homo sapiens*, are descended from such representatives of the species *Homo primigenius* as these (and there can be no valid objection to this assumption) the question arises: How, when, and why did we get our chins?

Immediately after the discovery of the bones at Krapina, Prof. Walkhoff of Munich ventured to suggest an answer, based on the results of the examination of the bones with the aid of Roentgen rays.

The new possibilities which have thus been opened to anthropology by recent progress in physics will be appreciated when we recall the difficulties which formerly attended the deciphering of such valuable human documents. These unique and priceless bones must not be sawed and sliced for the purpose of discovering their internal structure, nor is it certain that the desired result would be obtained by such mutilation.

More than twenty years ago there was found in a cave at Schipka, in Moravia, a human jawbone of great size and strength, but with the dentition of a child at the age when the milk teeth are being shed and replaced. Virchow expressed the opinion that the jaw was that of an old man with arrested dental development. But the Roentgen rays, which penetrate the hardest bone, showed that the jaw was really that of a child in which the change in dentition was occurring normally. From this fact and the massiveness of the jawbone it is fair to infer that the bone was that of a child of the ancient human species that possessed enormous jaws. After Walkhoff had settled this old controversy, he applied the new method of illumination simultaneously to the jawbones found at Krapina and those of modern men, and discovered a striking difference in the internal structure of the two species. The spongy tissue of the Krapina bones was found to be entirely devoid of the fine fibers or spicules of bone that are imbedded in regular arrangement in the spongy tissue of modern jawbones and other bones. Now, according to the new theory of osteology introduced by Prof. W. Roux, the internal structure of bones is intimately related to the attachment of the muscles by which the bones are supported and moved, the spicules being arranged, like the parts of a bridge or other structure, in exact accordance with the tensions and other stresses to which they are subjected. In the lower jaw, and especially in the well-developed chin of modern men, the spicules, in Walkhoff's opinion, are arranged in accordance with the muscular tensions that produce articulate speech.

Hence this complex fibrous structure which the Roentgen ray reveals in the interior of our jawbones and chins is an organ of speech, and the absence of such structure in the jaws of the Krapina men of the species *Homo primigenius* indicates that those men did not possess the power of articulate speech.

Their jaws were made for chewing, not for talking. We cannot think that they were dumb. They may have been able to communicate with each other by a great variety of distinct sounds, but they did not habitually execute the precise and finely differential muscular movements involved in articulate speech.

That faculty was reserved for the later, higher, true human species, *Homo sapiens*, and with its development came that of the chin.

If Walkhoff's view is correct, the horrible fate of these martyrs of Krapina has given us, their distant kinsmen, some insight into the great mystery of the origin of speech.—From the German of Wilhelm Boelsche in Ueber Land und Meer.

HOW AMUNDSEN PREPARED FOR THE ARCTIC.

Capt. Roald Amundsen, in Harper's, tells for the first time the story of the successful voyage of his little vessel through the Northwest Passage and his discovery of the north magnetic pole:

"The sloop 'Gjöa'—a vessel 73 feet long, 20 feet beam, drawing 11 feet of water when laden, and of 47 tons net burden—was built in Norway, in the Hardanger district, in 1872. Originally not intended for the Arctic, she subsequently drifted into the sealing trade, and for several years sailed from Tromsö in that capacity.

"On my purchase of her I had her entire fittings removed; and strengthened her with a number of stout wooden and iron beams and cross-ties; and as well as other necessary improvements she also received an outside skin of two-inch oak planking, reaching from the keelson to the water-line. Finally I put in a petroleum-engine of thirty-nine indicated horse-power, with a two-bladed propeller, such as is customary in vessels intended for arctic waters. A special apparatus was placed near the man at the tiller, enabling him to control the engine, to start or reverse it as occasion required, and this proved invaluable and of almost constant necessity after we had entered the ice. The engine was also fitted to hoist sails and anchor, run the pump, and haul in the deep-sea lead-line. The last, however, proved to be useless through the shallow waters of the Northwest Passage. The propeller, I should explain, was only to be considered in the light of an auxiliary, the sails being intended as the principal motive power of the vessel, as indeed they were throughout the voyage.

"My provisions consisted mainly of tinned foods, which were packed in tin-lined cases of uniform size, copper nails being used in their construction, so that the empty wooden cases might be utilized in the building of the magnetic observation stations without affecting the magnetic needle. In this way I solved a problem which had long puzzled me, my vessel being too small to carry an extra load of building materials. The plan proved to be a perfect one. With the empty wooden boxes filled with sand we constructed not only excellent observation stations, but also comfortable dwellings, which did excellent service and surpassed all expectations.

"The wearing apparel for the members of my expedition consisted of pure woolen underclothing, with outside garments of reindeer and sealskin. With re-

gard to the former I may mention that I followed their manufacture from the carding of the wool to the completion of the product, thereby guarding against adulteration, and securing a superior make of warm garments for my people.

"Our tents were made after a pattern invented by my friend Dr. Frederick A. Cook, of Brooklyn, and myself, and may be said to have contained the results of our experiences with the Belgian antarctic expedition, of which we both were members during the years 1897-99. These tents, which somewhat resemble those of the Eskimo, were intended for the use of two persons, were built of light duck, and could be pitched by one man even when a gale was blowing.

"It may sound almost incredible when I state that our small vessel contained provisions and ammunition for five years. Nevertheless such was the case; and the 'Gjöa' brought back with her considerable quantities of nearly every kind of provisions and stores, despite the fact that I gave some ice-bound whalers at Herschel Island some 2,500 pounds of flour.

"For fuel, lighting, and cooking purposes I took with me about 7,000 gallons of refined petroleum of the highest grade. Of this we still had about thirty per cent left on our arrival at San Francisco. Guncotton, ice-saws, extra fine and strong hawsers, several hundred volumes of books and many games to help while away the time during the long arctic nights, as well as everything else necessary to a well-equipped arctic expedition, completed our outfit on board the 'Gjöa.' The games for some reason or other were never taken into use by the members of the expedition, but were eagerly accepted by our many Eskimo friends, who became quite adepts at some of them."

AN ANCIENT ROMAN PUMP.

By PROF. KEUNE, Director of the Museum of Metz.

THE vicinity of the village of Sablon, near Metz, in German Lorraine, was thickly settled 1,500 or 1,800 years ago, as is proved by the numerous objects that have been unearthed there, especially in recent years. Near a ruined castle which sheltered the Emperor Charles V. during his unsuccessful siege of Metz in

FIG. 1.—A ROMAN PUMP FOUND IN AN ANCIENT WELL IN LORRAINE.

the year 1552, no fewer than 130 stone memorials of an old Gallo-Roman village, in addition to other objects, were laid bare by a railway cutting in 1903, and have been transferred to the museum of Metz. About twenty years ago a sacred well and fragments of temples and idols were found nearer the city. At Sablon a cemetery of the late Roman period has been discovered. Its size and the number of its graves indicate that it belonged to a populous community.

An object of very singular character, especially in view of its location, was found among the graves last year. The workers in a sand and gravel pit uncovered a well about 23 feet deep. The bottom of the well was square, lined with planks, and contained a pump.

That the pump dates from the Roman period is proved by the objects found about it. The débris with which the well was filled contained stones and Roman tiles that had belonged to the ruined well-house, bones of animals, and fragments of late Roman pottery, but no object of modern origin. Immediately above the pump were found charred human bones, shoes, and a bronze girdle clasp (Fig. 5) with late Roman (or early German) ornamentation. Strewn around the pump lay three antique jugs, made probably of tin (Fig. 3), a "face urn" or earthen pot bearing crude representations of human features (Fig. 4), a knife with a wooden handle, and various parts of the pump. All the objects have been presented to the Metz museum.

The pump (Fig. 1) consists of a block of wood in which two cylinders of lead are inserted. The tops of the cylinders have been exposed by the rotting of the wood, but the lower part of the block and all other wooden parts of the pump have been fairly well preserved, by moisture. A flaw in the block was patched with a sheet of lead bent at right angles and nailed to the side and bottom.

The lead cylinders were pump barrels in which pistons were moved up and down by a lever as illustrated by the diagram (Fig. 2). Two wooden pistons were found (Fig. 9). They had been turned in a lathe and had probably once been covered with leather or cloth packing. The bores in which the lead cylinders are fitted were prolonged downward to the level of the water, above which the pump appears to have been supported on beams. Below the cylinders are transverse passages leading inward and upward to a central

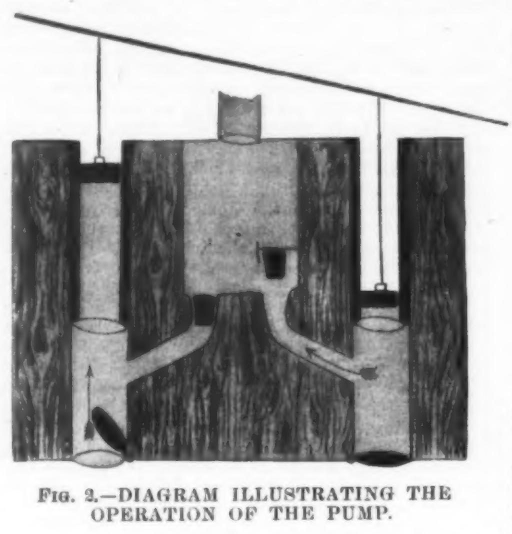


FIG. 2.—DIAGRAM ILLUSTRATING THE OPERATION OF THE PUMP.

cavity, now greatly decayed, from which a long wooden or more probably a leather tube must have risen to the mouth of the well. Three lead clack valves were found (Fig. 7). Two of them, faced and hinged with leather or cloth, must have been placed at the bottoms of the vertical borings and the third at the bottom of the efflux pipe. Two conical valves were also found (Figs. 6 and 8). These are made of wood, still partly covered

FIG. 3.—ROMAN TIN JUG.

FIG. 4.—ROMAN FACE URN.

with leather, and were loaded with metal in order to oppose sufficient weight to the pressure of the water. They were obviously placed in the ends of the two lateral passages, at the bottom of the central chamber. Fragments of the piston rods were also found. The action of the pump is illustrated by the diagram (Fig. 2). When the lever is moved so as to raise the left-hand piston and depress the other, a partial vacuum is produced in the left barrel, the clack valve at the bottom is raised by the pressure of the water beneath, and water enters the cylinder through this valve. The

FIG. 5.—BRONZE GIRDLE CLASP.

conical valve, pressed hard against its seat in consequence of the vacuum, prevents the reflux of water from the central chamber. At the same time the descent of the piston in the right-hand barrel forces into the central chamber the water that has been drawn into the right-hand bore in the preceding stroke, the clack valve being closed by the pressure above and preventing any escape of water at the bottom of the bore. In the next stroke the operations of the two sides are interchanged and thus water is forced almost

FIG. 6.—CONICAL VALVE.

continuously into the central chamber and thence through the efflux pipe to the top of the well.

The apparatus closely resembles the old-fashioned hand fire engine. The device is more than 2,000 years old. It was invented by Ktesibios of Alexandria (B. C. 250-200) who also invented an improved ballistic weapon and organs operated by both air and water. His pump, according to a description given by Vitruvius, the Roman architect (B. C. 14), was made of bronze. At the bottom were two barrels which were connected with a vessel placed between them by pipes, the mouths of which were provided with valves. Two other valves were placed at the bottoms of the pump barrels over the holes which admitted the water. In the barrels pistons, carefully turned and oiled, were moved by rods and levers, forcing air and water into the central vessel whence the water was driven upward through a pipe by the force of the compressed air.

Hero of Alexandria and Philo of Byzantium made improvements on this apparatus. A pump which agrees with Hero's description was found in the eighteenth century near Civitavecchia, in Italy. This like the pumps of the old descriptions, was made of metal.

The Romans designated a pump of this sort by the

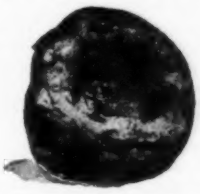


FIG. 7.—LEADEN CLACK VALVE.

name *sipho*, a word borrowed from the Greek but probably of Oriental or Egyptian origin. They employed the apparatus chiefly for extinguishing fires, but instead of pumping water directly on the fire they used the *siphones* only to pump water from streams and wells into large vessels from which it was carried to the fire in buckets. These fire buckets (*hamæ*), pumps (*siphones*), and bundles of rags saturated with water (*centones*) constituted the chief means of fighting fire, and pumpers (*siphonarii*) were included in the military corps of watchmen and firemen (*vigiles*) that guarded the imperial city at night. In 112 A. D. Pliny the Younger, in consequence of a disastrous conflagration in Bithynia, of which province he was governor, requested the Emperor Trajan to send him a fire company of 150 artisans. Many Roman cities had such companies, the members of which were not exclusively firemen but had some other occupation. Usually they were builders.

It appears, therefore, that the ancients were not quite so ignorant of natural laws as we are apt to assume. They had fire engines resembling some still in use and they knew that water attains the same level in communicating pipes of any length and form. They made use of this principle to supply Rome with water from a high tower, and in places they had complete systems of water pipes. They also possessed machine guns, though the torsion of fibers was used, instead of gunpowder, to propel the missiles,* and Nero

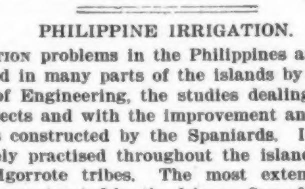


FIG. 8.—CONICAL VALVE OF WOOD COVERED WITH LEATHER AND WEIGHTED WITH METAL.

wore an eyeglass.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

PHILIPPINE IRRIGATION.

IRRIGATION problems in the Philippines are being investigated in many parts of the islands by the insular Bureau of Engineering, the studies dealing both with new projects and with the improvement and extension of works constructed by the Spaniards. Irrigation is extensively practised throughout the islands, even by certain Igorrote tribes. The most extensive works are those constructed by the friars. One of the studies made by the Bureau was the investigation of the dams, ditches and tunnels of the irrigation works in Cavite Province. This system on the estates previously owned by the friars is the result of more than a century of intelligent development. It is estimated that 25,935

FIG. 9.—WOODEN PISTON.

acres have been under irrigation. The number of dams examined was 43, about half of those connected with the works. The heights varied from 10 to 75 feet, the largest being 50 feet high and 900 feet long. They are constructed of masonry, laid in horizontal beds about 15 inches thick. Lime mortar is used exclusively. The profiles vary greatly, but all are generous. Notwithstanding the use of lime mortar, there is little leakage through the dams, and the leaks that

* "Roman Ordnance," SCIENTIFIC AMERICAN, January 27, 1906, p. 95.

have been found were probably due to cracks caused by earthquakes. The earthquakes, however, have not done any considerable damage in this district. The works, on the whole, are in good condition, though there are few dams in which the aprons do not need some repairs. Mr. H. F. Labelle, assistant engineer of the insular Bureau of Engineering, who reported on these works, estimates the cost of these repairs at $5,650. The ditches and tunnels in many of the systems were built with too flat a slope, and as a consequence from 6 to 12 inches of sediment has been deposited in them. The sections of the tunnels, which resemble each other closely, are 4 to 7 feet wide, and 5 to 7 feet high. They are cut through the rock, and have no lining. The tunnel arch is circular, or elliptical, and in one case a pointed arch is used. Several of the longer tunnels have shafts, some of them lined with masonry, which facilitate the cleaning of the tunnel. More than half of the canals and tunnels issuing from dams have no head-gates or regulating works, and in only one case are stem-operated gates in use.—Engineering Record.

THE PLANET MARS AS REVEALED BY RECENT OBSERVATIONS.

By the Abbé MOREUX, Director of the Observatory of Bourges.

ALTHOUGH the apparent diameter of Mars, even at the oppositions most favorable for observation, which occur at intervals of fifteen or seventeen years, is only 25 sec., and its apparent area only 1-5,000 of that of the full moon, a good deal of detail has long been seen on its surface. From this fact it is inferred that the Martian atmosphere is of very small density.

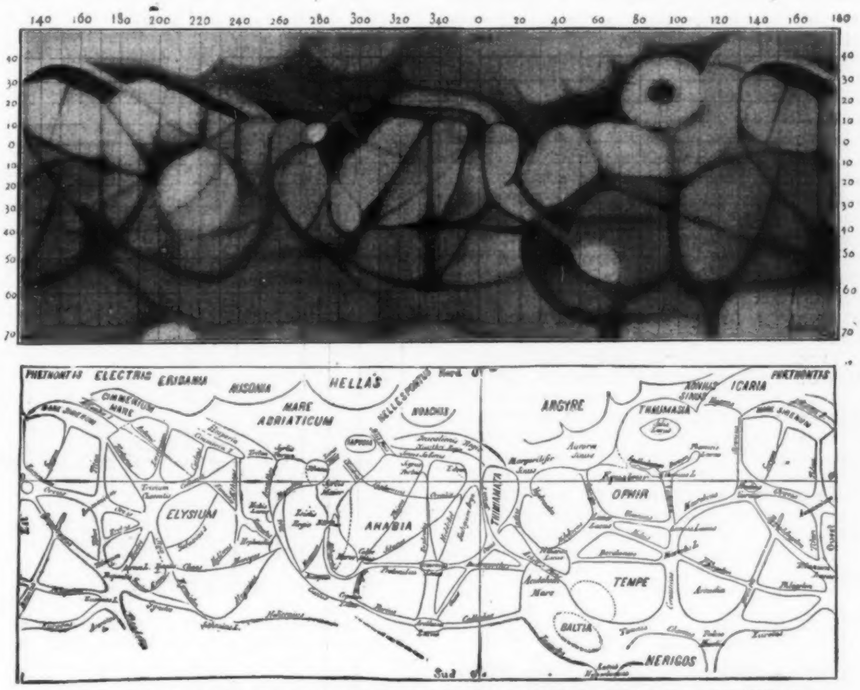


FIG. 3.—DRAWING AND MAP OF MARS ON MERCATOR'S PROJECTION, SHOWING THE DETAILS OBSERVED DURING THE OPPOSITION OF 1905 BY THE ABBÉ MOREUX AT THE OBSERVATORY OF BOURGES.

The surface may be divided, roughly, into large orange or red "continents," and blue-green "seas." The seas are connected with each other by blue-green streaks which were called rivers until Schiaparelli gave them the name of "canals." A remarkable evolution may be traced in Schiaparelli's drawings, the canals gradually becoming narrower and straighter. Most of them are perfectly straight in his large map embodying all his observations from 1877 to 1888. Schiaparelli was the first to observe the gemination or doubling of certain canals. At the opposition of 1905 Prof. Lowell, employing a telescope of 24 inches aperture in the clear air of Flagstaff, Ariz., 7,200 feet above sea level, observed and charted 420 rectilinear canals. According to Lowell and others, the canals are not confined to the orange, but extend over the blue regions, which consequently cannot be bodies of water. At intersections of canals Lowell observed round, dark spots which he calls "oases."

Many astronomers, including Lowell, think that the canals are artificial and constructed for the purpose of irrigation. Others dissent from this view and hold that the remarkable straightness of the canals as seen by some observers and the appearance of numerous fine canals are due to optical illusion. In an experiment by Maunder and Evans, pupils were requested to copy maps of the general configurations of Mars placed at a great distance. In most cases the pupils connected bays and mouths of canals by fine straight lines. Maunder has pointed out (in Knowledge, May, 1904) that very small spots, whatever their real shape, appear round and that there is a tendency to connect them by straight lines and to combine several irregular lines into one straight line. He instances a drawing which appeared to him at a distance to contain a straight and intensely black line which nearer inspection resolved into several broken and sinuous lines and minute dots.

The fine canals, again, may be merely the boundaries of differently colored areas by which the eye is impressed more strongly than by the tints themselves. The whole science of drawing is based on this principle, for there are no lines in nature. Capt. Molesworth, at the opposition of 1900-1901, announced this conclusion in regard to the fine canals.

The extent of our knowledge of Mars may be illus-

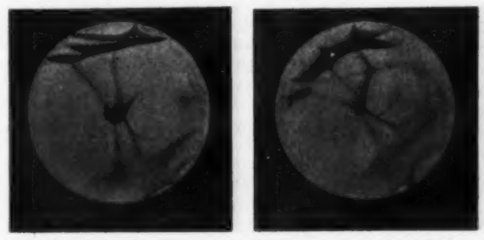


FIG. 1.—CHANGE OF ELYSIUM AND TRIVIUM CHARONTIS FROM APRIL 3 TO MAY 9, 1905.

trated by a comparison. A telescopic view of the moon is altogether different from the appearance which the satellite presents to the naked eye. An enlargement of 75 diameters reveals details which would not even have been suspected. But Mars when magnified 75 times appears about as large as the moon seen with the naked eye, and magnifications of over 300 are seldom used, because they are unsatisfactory.

Many astronomers have maintained that Mars, unlike the earth and the moon, possesses no high mountains. But the height of the lunar mountains is revealed to us only in certain conditions of illumination depending on the height of the sun above the horizon of the given lunar region. Now Mars, when in the best position for observation, is situated as the moon is three days before the full. The slight irregularities of the lunar terminator at this epoch would probably be hidden by an atmosphere no denser than that of Mars, and thus

FIG. 4.—REGION OF SYRTIS MAJOR AT THE BEGINNING OF JUNE, SHOWING FINE CANALS.

the existence of high lunar mountains would be a disputed question.

A drawing of a planet as seen through the telescope is the result of many successive retinal impressions, for no eye can see all the details at once. After drawing the conspicuous and unmistakable markings, the observer fixes his attention on slight variations of color and lines which are at the limit of visibility. The task is difficult, for the air is always in motion, and the eye soon becomes fatigued, so that fine details are caught for an instant and then vanish. Sometimes the definition is so poor that no confidence can be placed in the observations.

In the accompanying illustrations, selected from my drawings of the opposition of 1905, I have included none in which the definition was not perfect.

At first Mars appeared to me as a globe variegated in color, but not crossed by straight, dark lines. Only the seas were sharply defined. The canals were broad

FIG. 2.—SYRTIS MAJOR COVERED WITH FOG ON MAY 2 AND SEEN DISTINCTLY ON MAY 5.

and shaded off gradually at the edges. Their predominating color was a very dark moss-green. These effects cannot be reproduced with the pencil. Brushes, or preferably pastels, should be employed. The drawings of Secchi, Lockyer, Molesworth, and others prove that the planet often presented a similar aspect to those observers. Some of Phillips's drawings of the recent opposition are almost identical with mine.

In May, however, some of the canals became more linear. The *Trivium Charontis*, at first a large, dark green spot with a shaded border, contracted, and the canals ending in it became narrower and more numerous. These changes are shown in Fig. 1. In time the southern part of the *Syrtis major* became darker and its details beautifully clear (Fig. 2).

Generally speaking, the surface was composed of broad light and dark patches. Distinctly linear canals were rare.

At first nearly all the seas were uniformly blue-green. A few occasionally showed a violet tint, due probably to atmospheric disturbances on Mars. The

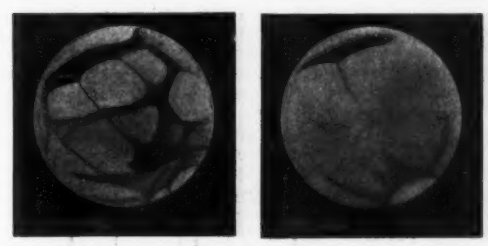


FIG. 5.—MARE SIRENUM SEEN DISTINCTLY ON MAY 10 AND OBSCURED BY A DENSE FOG ON MAY 12-13.

general color appeared to vary with the diameter of the objective, shading toward indigo with small apertures. The edges of the seas were always sharp in good atmospheric conditions on the earth and Mars. As the opposition progressed the general color passed insensibly into greenish brown and then into chocolate brown. I say the general color, for attentive examination revealed local tints varying from deep blue to green and even to brown. The appearance was that of an intricate and irregular marquetry. The forms of the variously tinted sections escaped me. Probably they could be discerned with large telescopes, but as strong magnification diminishes contrast, only the lines of demarkation would be perceived. This is probably the explanation of the intricate pattern of lines seen and drawn by Prof. Lowell.

The transition from green to brown did not occur simultaneously in all parts of the planet. There is a seasonal variation, but the changes do not exactly follow the melting of the polar snows or depend on the latitude alone. I often saw white streaks in the seas.

Early in April I was impressed by the fact that very few canals were clearly visible. It was necessary to look long in order to make them out, in the form of narrow lines. The word canal, by the way, is applied to objects of very different characters. Some of the regions which are called canals might as properly be called seas. For several weeks the width of *Ceraunius* was equal to 10 degrees of Martian longitude. Sometimes the region between two canals resembled a sea, being darker than the adjacent continents. The only

appreciable difference between seas and canals was that the borders of the seas were always well defined, while those of the canals were generally indistinct. The indistinctness, however, varied from day to day. Sometimes it was very difficult to follow the course of a canal through the darker territories. Other canals came out strongly from a bright orange background and appeared to consist of chains of knots, alternately large and small. At the end of the opposition many canals were very sharply defined, while others had become so indistinct that they were barely distinguishable. Here, again, there was no systematic difference according to latitude.

I saw no double canals during the whole course of the opposition, nor did I see any dark round spots at the intersections of canals.

The large drawing of the planet (Fig. 3) does not show the exact appearance of all the markings at any one instant, but contains details noted in ninety-eight nights of observation.

In general, the forms, colors and changes of the markings appear to me very natural and I fancy that the earth, in the absence of the diffusive action of its atmosphere, would present a similar appearance to an observer on the moon.

We do not know the real nature of the so-called canals and seas of Mars, but the hypothesis which attributes them to vegetation is supported by the observed seasonal change and appears satisfactory. The recorded displacements of canals and boundaries and the appearances of new "lakes" may be explained by seasonal, annual, and secular changes in vegetation.

As the atmosphere of Mars is almost certainly far less dense than ours the effects of changes in solar radiation must be greater on Mars than on the earth, and it is well known that our climatic variations from year to year are governed largely by the condition of the sun. Hence it is not surprising that the area and arrangement of the green patches on Mars differ greatly in different years.

The main topographic lines, however, have long been fixed. The change is only in details. Too little attention has been given to the changes of this character that occur during a single opposition. My drawings of *Syrtis major* in May and June (Figs. 2 and 4) strikingly illustrate the rapidity and extent of these changes.

It has been repeated for more than a century that the atmosphere of Mars is not only thin, but perfectly clear, and this assumption has led to very unfortunate consequences. Whenever an observer was unable to see fairly sharp detail he attributed the indistinctness to terrestrial atmospheric conditions and postponed his observations to a more favorable opportunity. But a careful study of the matter would have shown that in the majority of cases the lack of detail was not caused by poor definition. In many such cases the limb of the planet appears perfectly sharp, without appreciable tremors or deformation. The difficulty in distinguishing details is due to the presence of fogs on Mars. A drawing made under these conditions, formless though it may appear, is as valuable and instructive as one filled with detail. I observed several cases of this kind in the course of the recent opposition. At the end of April the region surrounding the boreal pole (the bottom of the figures) became very indistinct and remained so for several days, but on May 5 it returned to its original aspect (Fig. 4).

Again, on May 10 and 11 I was able to draw many details, but on May 12 and 13, although the sky was very clear and the definition perfect, the markings of the planet (except in a small part of the southern hemisphere, which remained sharply defined) were as indistinct as if covered with ground glass. Most of the canals were invisible for several days (Fig. 5).

On May 18 a white haze covered over the austral region, while the boreal hemisphere, hitherto veiled, appeared in fine detail. Two days later the whole planet was enveloped in fog.

These examples and many others prove that the atmosphere of Mars is not as clear as is commonly assumed. Every few days I saw evidence of fog in one region or another.

I also observed another very curious effect—the occasional coloration of parts of the planet by its atmosphere. The regions affected were near the poles, but the color—blue—was deepest at some distance from them. The color extended over seas and continents, sometimes concealing and sometimes revealing the configurations. A rose tint was also observed.

Now a color extending over seas and continents and varying throughout from day to day cannot be a property of the surface of the planet, but must be due to the overlying atmosphere. This view agrees with our knowledge of the colors of our own atmosphere. According to Prof. Sagnac* the blue color of the sky is the effect of diffusion of the solar rays by very fine particles. These particles are possibly the air molecules, and the blue tint is produced chiefly in the upper and more rarefied strata of the atmosphere. Prof. Sagnac has proved by experiment that the violet and ultraviolet rays are diffused even more strongly than the blue rays, so that the sky would appear violet if our eyes were sufficiently sensitive to rays of short wave length. Hence in the more attenuated atmosphere of Mars the blue should tend toward violet, as observation proves it to do. The fact that the coloration is most intense in the polar regions may be explained by the comparatively small quantity of water in the atmosphere of those regions.

The temperature of Mars has been much discussed. How can the complete disappearance of the polar snow caps be reconciled with the fact that the solar radiation is only 43 per cent of the radiation received by the earth, where the polar caps do not melt?

Prof. Poynting has sought to determine the temperatures of the planets by Stephan's law of the fourth powers. He finds that the temperature of a small black body would be 81 deg. F. in the position of the earth and —22 deg. F. in the position of Mars. These figures appear to be approximately correct, for the observed mean temperature of the earth is about 63 deg. F. This discrepancy of 18 deg. F. is due to the size of the earth and loss of solar radiation by reflection. If we suppose these causes to have an equal effect on Mars, that planet's mean temperature will be —40 deg. F. This is 103 deg. F. lower than the mean temperature of the earth. If the same difference exists between maximum air temperatures on the two planets the maximum air temperature at the equator of Mars would be a little above the freezing point of water, but the air temperature at the poles could never exceed —33 deg. F.

The surface of the ground, however, is often warmer than the air. Nansen found that a thermometer exposed to the sun on a sledge indicated 88 deg. F. when the air temperature was only 12 deg. F. A difference of this magnitude (76 deg. F.) would account for the melting of the Martian polar snows, notwithstanding the low temperature of the air.

Furthermore, the tenuity of the Martian atmosphere, which appears to have only one-third of the density of ours, must greatly increase the effect of the sun's rays and also promote the evaporation of water and the conservation of its latent heat. Here, no doubt, we come to a very important factor in the meteorology of Mars. Because of the low atmospheric pressure, water, probably, cannot long remain liquid. During the day it exists as saturated vapor in the atmosphere. The sudden cold of night or even the slightest fall of temperature produces mists and fogs which reflect the sunlight. This is precisely what we observe at the edge of the disk, that is to say, at Martian sunrise and sunset. A greater reduction of temperature produces a fall of snow, with which certain regions, probably high plateaus, appear to be covered. But even the polar snow cannot attain a great depth or it would not vanish, even in a summer twice as long as ours. In the temperate and tropical zones the water vapor with which the air is saturated must be deposited at night in the form of very heavy dews, which probably constitute the sole water supply of Martian vegetation.

But the fogs of the night are not always dissipated by the sun, as appears from the observations described above. The persistence of local fogs offers a plausible explanation of the doubling of the canals. What supposition is more natural than that the valleys are filled in autumn with mists which the waning power of the sun is unable to disperse. The mists would accumulate at the bottom of the valley, leaving exposed the approximately parallel flanks still covered with vegetation. The white canals or streaks in the great dark spaces, improperly called seas, probably have a similar origin.—Abstracted for the Scientific American Supplement from Revue Générale des Sciences Pures et Appliquées.

* Scientific American Supplement No. 1601, September 8, 1906.

INVESTIGATION OF EFFECT OF ELECTRIC LOCOMOTIVES ON CURVES.*

I need not give here a discussion of the problem, neither is it necessary to call your attention to the uncertain elements involved. I will simply say that in my computations I have assumed a coefficient of friction between wheel and top of rail as 0.25, and the coefficient of friction between base of rail and tie plate as the same. The action of the pony truck, which is transmitted to the rigid frame by means of the spring and pivot, has been taken account of in each case, but the friction on the sliding plate by which the vertical load is carried to the pony truck has been considered separately, in order that it may be omitted, if it is thought that it ought not to be allowed for.

The second driving axle has a certain amount of play laterally, so that it would tend to work to the outside of the curve, and make the pressure on the forward driver less than if the forward driver were the only one upon which the pressure were exerted. Whether the second driver will come into action in this manner depends upon its play laterally and upon the precise position which the locomotive assumes upon the track, as well as upon the perfection of the alignment of the track. This I have studied with various positions of the truck upon the track as follows:

1. In which the rear driving axle is radial, with inside wheel close against inside rail.

2. In which rear driving axle is pushed outward a little until outward wheel of rear pony is against rail, but without compressing the spring.

3. In which the rear driving axle is pushed outward still further until outer rear driver is in contact with the outer rail.

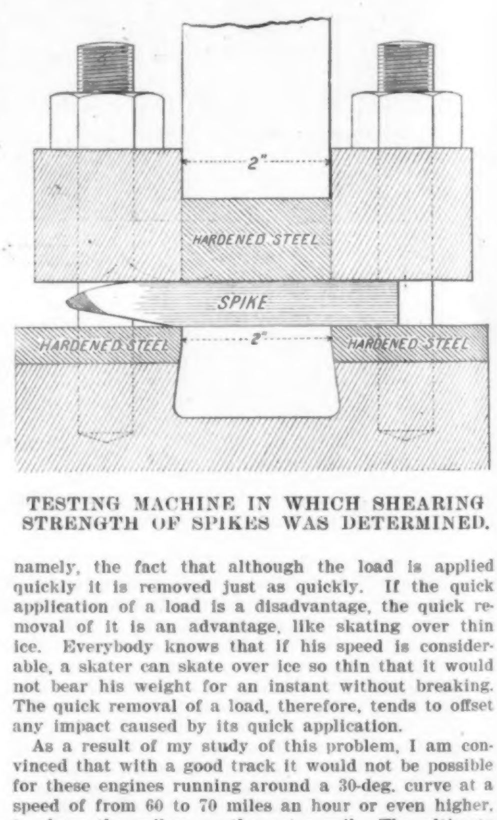
With the play of the second axle as given to me, it would be possible in each of these three cases for the second outer driver to be in contact with the outer rail, but the margin for possible inequalities in the track would be different in the three cases; for 1 it would be about 3-100 inch, for 2 it would be about ¼ inch, and for 3 it would be about ¼ inch. In other words, it is more probable that the second driver would relieve the leading driver if the position were as assumed in case 2 than it would be if the position were as assumed in case 1, and more probable still if the position were as assumed in case 3.

The accompanying table gives a summary of the conclusions arrived at.

Another point of some uncertainty in the problem is as to the distribution of the pressure of the forward driver upon the spikes. If this pressure is exerted directly over a tie, the outer spike on that tie would carry a greater portion of the pressure than any other spike, and if no yielding could occur either in tie or in spike, this spike would carry the whole of the load. Any yielding, however, no matter how slight, would distribute the load upon the two spikes on either side, these two carrying less than the first spike. In a similar manner, if the pressure were exerted midway between two ties, the two spikes on these ties would carry one-half the load, if no yielding would occur; but any yielding, however slight, would distribute the load upon other spikes on either side. It is impossible for anybody to tell just how much pressure would be carried upon the spike which is most stressed, but it would be my judgment that the pressure should be considered as distributed upon two spikes. It is possible to imagine cases in which nearly the whole load might be carried by one spike, but those would be cases where the track could not be said to be very perfect.

Another uncertain element in the problem is the question of impact. The pressure upon the spikes is not *suddenly* applied, but is applied very quickly, and with a good track it would not be applied with a shock; there would be a steady pressure of the outer wheel against the rail in passing around a curve. If the load were applied instantaneously to a spike the impact would be 100 per cent; if the load is applied gradually, as it is in fact, the impact will depend upon whether it is applied more quickly than the strain can follow it.

Another element, also, must be taken into account,



TESTING MACHINE IN WHICH SHEARING STRENGTH OF SPIKES WAS DETERMINED.

namely, the fact that although the load is applied quickly it is removed just as quickly. If the quick application of a load is a disadvantage, the quick removal of it is an advantage, like skating over thin ice. Everybody knows that if his speed is considerable, a skater can skate over ice so thin that it would not bear his weight for an instant without breaking. The quick removal of a load, therefore, tends to offset any impact caused by its quick application.

As a result of my study of this problem, I am convinced that with a good track it would not be possible for these engines running around a 30-deg. curve at a speed of from 60 to 70 miles an hour or even higher, to shear the spikes on the outer rail. The ultimate strength of a spike, I am informed, has been found by tests to be 17,000 pounds. If the cross-section of the spike were reduced by wear by one-ninth, as has been stated to be the case, the breaking strength would be reduced to 15,100 pounds. I do not believe the pressure of the leading driver against the outer rail at a speed of 60 miles an hour would be above 3,000 pounds (and it assuredly would not be above 5,200 pounds) or at a speed of 70 miles an hour above 3,500 pounds (and it would assuredly not exceed 8,400 pounds), so that there would be a considerable margin in either case. It must further be borne in mind that it will require a stress considerably above the elastic limit in order to break a piece of metal, even with many thousands or millions of applications, the number of applications required being less as the ultimate strength under a single application is approached. For instance, reliable tests indicate that for steel in tension a stress of seven-tenths of the ultimate strength would have to be applied some 4,000,000 times in order to break a piece, and that a stress of about five-eighths of the ultimate strength would require 6,000,000 or 7,000,000 applications. Experiments, of course, vary with regard to the number of applications necessary. If there is any defect in the material at any point, the effect of repeated applications is to cause a failure at this point and with a less number of repetitions than if the material is perfect, but even with a defect a stress of seven-tenths the ultimate is likely to require half a million or more applications.

* Abstract of Report to New York Central Railroad Company by George F. Swain, Professor of Civil Engineering, Massachusetts Institute of Technology.

TABLE.

Miles per hour..............	57 6	60	70	80	90
1. Allowing for friction between base of rail and tie plate, but not for friction of sliding plate of pony truck or for pressure ot second drive against outer rail, the pressure of leading driver against outer rail will not exceed....	4300	5200	8400	12,800	16 800
2. If friction of sliding plate of pony truck is also allowed for, pressure on leading driver against outer rail will not exceed...........	3200	4100	7300	11,200	15,700
3. If second driving axle slides laterally so as to bear against outer rail, pressure of leading driver will not exceed	2100	3000	6200*	10,100†	14,600‡
Friction on base of rail under outer leading driver..........	4375	4435	4735	5,085	5,500
My belief is that on an approximately perfect trac the pressure of the lea ing outer driver would not exceed the following.	3000	3000	3700	7,500 to 8,000	11,000

* And will probably not be over 3,000.
† And will probably n .t be over 6,800.
‡ And will probably not be over 11,000.

TEST ON FULL-SIZED NEW YORK CENTRAL SPIKES, MADE BY ROBERT W. HUNT & CO., ENGINEERS, NEW YORK.

We made tests of six Goldie track spikes in double shear, using the shearing blocks as shown in accompanying diagram. These shearing blocks do not give a knife-edge shear, but in our opinion approach very closely the actual shearing, bending, and tension stresses obtaining in actual service where a spike is sheared off by flange of rail.

The results of tests are given below.

The elastic limit, or rather the yield point, was obtained as closely as possible from the action of the beam of the testing machine and also from a close observation of the spike itself. We believe that the approximate elastic limit obtained under the given conditions does not vary more than 2½ per cent from the actual.

There was practically no bending of the spike until the elastic limit was reached.

RESULTS.

Test Number.	Width of Spike.	Height of Spike.	Approximate Elastic Limit.	Maximum Load.
	Inch.	Inch.	Pounds.	Pounds.
1	0.624	0.622	9,500	37,880
2	0.591	0 608	10,500	40,460
3	0.631	0 592	10,500	38,640
4	0.630	0 597	12,000	38 820
5	0 626	0 601	10,900	40,940
6	0.634	0 600	10,000	40,160
Average...	0.6226	0.6048	10,566	39,481

Average approximate elastic limit or yield point in either double or single shear, pounds actual, 10,566.

Average single shearing load of spike, pounds actual, 19,740.5.

Average single shearing load of spike, pounds per square inch, 52,420.

These results were obtained in the straight portion of the spike. While the spike in service would fail nearer the head where the area would be greater, the area of the spike where tested was 0.3765 square inch, and the area of the spike at the base of rail where the shear would probably take place is about 0.4225 square inch; therefore, the approximate elastic limit and the shearing load at the latter point would be in the proportion of 0.4225 to 0.3765, when compared with those actually obtained in the straight portion of the spike.

The approximate elastic limit and the shearing load of the spike at the base of rail would therefore be 11,855 and 22,145 pounds respectively.

After conferring with you in relation to shearing tests of spikes, we learned that one of the universities in this locality had testing blocks which would give a knife-edge shear. You will note that with these testing blocks the entire spike is rigidly clamped, and there cannot be any bending of the portion of the spike corresponding to the head and a short length of the shank, as would probably be the case in service.

We had the heads cut off four spikes and tested in this device, with the results given below. You will note that the approximate elastic limit or yield point is raised when tested under these conditions, and the maximum shearing load is lowered.

RESULTS.

Test Number	Width of Spike.	Height of Spike.	Approxiate Elastic Limit.	Maximum Load.
	Inch.	Inch.	Pounds.	Pounds.
8	0.624	0 608	13,000	36,550
9	0.627	0 598	14,000	38,790
10	0.625	0.592	12,000	37,810
11	0 627	0.606	11,500	36,880
Average....	0.6257	0.601	12,625	37,507

Average approximate elastic limit or yield point in either double or single shear, pounds actual, 12,625.

Average single shearing load of spike, pounds actual, 18,753.

Average single shearing load of spike, pounds per square inch, 49,807.

The approximate elastic limit or yield point and the shearing load of the spike at the base of the rail would, therefore, be 14,165 and 21,062 pounds respectively.

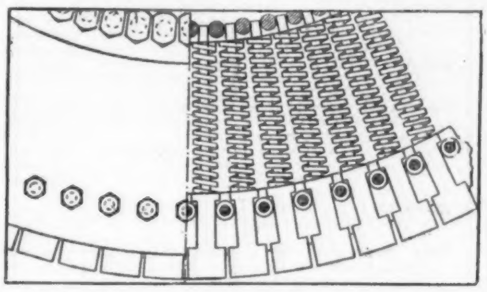
We are sending you by messenger the testing blocks used on the first six tests, also pieces of all spikes tested.

Spike No. 2 was not sheared entirely in two, the testing machine being stopped after the maximum load was reached. This was done in order that you might see the shape of the spike just before shearing took place.

The three pieces of each of the other spikes tested are stamped with the same figure, so that they can easily be assembled.

THE CENTIPEDE RESILIENT WHEEL.

ALL motorists are agreed that, for many purposes, a substitute for pneumatic tires is highly desirable, and to this end numerous forms of spring wheels, resilient

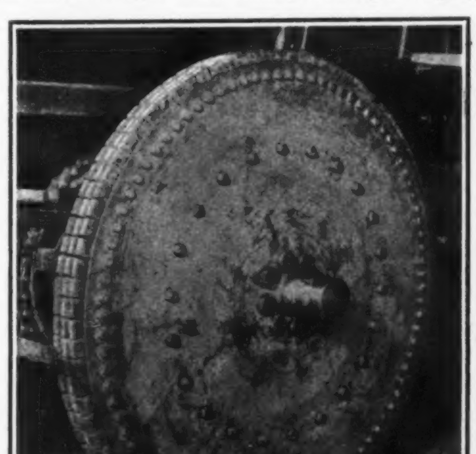


SECTIONAL VIEW OF THE CENTIPEDE WHEEL.

hubs, etc., have been invented. In all of them, however, the one great advantage of the pneumatic tire is wanting; that is to say, they have not the ability, which the pneumatic tire has, of absorbing small obstacles, such as stones and the like, which are met with on the road, owing to the fact that they are formed with a tread, or periphery, of a rigid and non-resilient nature. All such wheels are therefore bound to lift over every obstruction and irregularity on the road surface, and, as a consequence, to transmit a considerable amount of vibration to the hubs.

The wheel under consideration is the only one I have seen which really attacks the problem at the right point, the point of contact between the tire and the road surface. It is the invention of Mr. Frederick Wicks, who is so well known as the inventor of the rotary type-casting machine, and it has already gone well beyond the experimental stage. The accompanying drawing and photograph make the method of construction of the Centipede wheel so obvious that no lengthy description is really necessary.

It will be seen that the periphery of the wheel, i.e., the tread, is formed by a number of steel pedals or sections; these are all separated from one another, but are yet spaced so closely that they form practically segments of a continuous ring projecting beyond a solid frame. Each of these sections has a superficial area in contact with the ground of less than one inch, and is continually pressed outward, or kept extended, by means of coil springs, the long shanks meantime passing between rollers, which act as guides in permitting of their inward and outward movement. In the case of a light wheel dealing with light weights,



HOW THE WHEEL ABSORBS STONES.

only one ring of pedals would be necessary, but for heavier weights several series of rings divided from one another by suitable disks would be used, so that the tread would consist of an area of resilient projections. These pedals are then capable of dealing separately with all obstructions and irregularities in the road. Obstacles such as stones the size of a walnut are entirely absorbed by one or two of the pedals, which give way before them, leaving the remaining pedals to deal with the load. Other classes of obstruction, such as the raised edge of a manhole grating or a stick, might conceivably depress an entire series of pedals across the tread of the tire. Even then, however, there would be still left from sixteen to twenty pedals to carry the vehicle, and not the slightest shock would be felt. Larger obstacles, of say two or three inches in diameter, would, of course, be too much for the resilience of the Centipede, or even a lightly-blown pneumatic tire, and in the ordinary way would be avoided by the driver whenever possible.

Each of the springs behind the pedals is capable of two inches of compression before it is exhausted, although in normal running on a level surface the compression is only one-eighth of an inch for every forty pounds of dead weight carried; the whole tread will therefore support half a ton. This resilience, which corresponds approximately to that of a lightly-inflated pneumatic tire, can be hardened up to nearly three times the amount by increasing the strength of the springs, still without departing from the principle of the idea.

Mr. Wicks's design for a motor omnibus tire provides for a series of six rings of pedals, seventy-two pedals being in contact with the road; each of these requires 376 pounds to exhaust its resiliency, or in other words, every row of pedals will support nearly one ton before exhaustion. It will thus be seen that the Centipede wheel lends itself specially to motor omnibus work, where the total load is somewhere about six tons. It might be thought the tire would be noisy, but just the reverse is the case, because being of such an essentially yielding nature it never strikes a blow, but runs smoothly and almost silently over the most uneven surfaces. What noise there is can be compared to the rippling sound given out by the driving chains, and even this could easily be deadened, if necessary. An important part of the design is that the quality of the resilience can be calculated with exactness, and varied to suit the precise conditions of the weight to be carried. Its non-skidding qualities, too, are, of course, one of its most important claims to consideration. The wheel depicted in the illustration is one of a pair fitted to a motor-cab in which I had a trial over some specially selected and villainous pieces of road in London, including loose stones, very bad and neglected macadam, granite setts, and granite crossings. The result was so satisfactory that I shall be surprised, indeed, if the Centipede wheel does not obtain considerable attention.—The Car.

SCIENCE NOTES.

Every botanist will find Prof. E. W. Oliver's address before the British Association on the "Seed, a Chapter in Evolution," of extreme interest. The evolution of the seed was one of the most pregnant new departures ever inaugurated by plants. Conquest of the ancient world was as now slow in those earlier stages as yet only glimpsed in the Pteridosperms. The far-flung forests of Lepidodendrons and Calamites were not at once reduced to Lycopods without a struggle; for *Lepidocarpon* shows a great, if ineffectual, advance in the direction taken by the eventual victors. Probably seed plants asserted themselves wherever physical changes overwhelmed old habitats; just as with more pronounced dominance of the angiosperms, a future age may have to content itself with dwarf gymnosperms like those the Japanese are so fond of producing in their pot-cultivations. In glancing back of the earliest seed structures thus far discovered one is struck by their complexity. The pollen chamber, the large elaborate integument, and the complicated vascular arrangements, all these earlier improvisations and incidental features, protective or otherwise, have passed away or ended in essentially simpler but more exact structural devices. Once universal, aquatic fertilization has yielded to xerophyllous siphonogamy. Instead of sperms discharged into a water chamber abutting the archegonia, male cells are now carried through a plastic tube to the egg; as Prof. Oliver graphically puts it, much as we now journey from Baker Street to Waterloo with accuracy and dispatch by a sub-potamian tunnel, whereas our primitive ancestors first penetrated the forest and then swam the river! Seeds, in short, are in their nearer aspects the adjustment of filicinean organs to intraseminal limits, and in their far broader significance the response of the plant to the genesis of seasonal periodicity from aquatic generalized tropical conditions.

A beautiful aquatic plant, the water hyacinth, is according to Mr. George Massee in this month's Knowledge, causing the greatest anxiety in New South Wales, owing to its rapid extension in the creeks, lagoons, and more sluggish rivers of that country, thus impeding navigation. When growing in shallow streams or lagoons, it tends to suck up the water, and converts limpid streams into bogs. The plant is a native of tropical South America, and, being very showy, is much cultivated. Its spread in New South Wales is traced to a few plants having been thrown into Swan River by a local resident, who cultivated it as a decorative plant. The water hyacinth is an aquatic, and usually floats freely without being attached to the soil; when growing in shallow water or swamps the roots grow into the mud. If the mud becomes dry, the plant perishes. The leaves are roundish and arranged in a dense rosette one or two feet high; the lower portion of the leaf-stalks are much swollen and filled with air, and serve as buoys insuring the stability of the plant, and preventing its being overturned by wind or waves. The roots form a dense tuft one or two feet long. The flowers are produced in profusion, of a lilac color, and arranged in clusters like those of the hyacinth, hence the popular name. The plant is reproduced abundantly by stolons or shoots from the parent stem; these stolons, when about six or nine inches long, form a rosette of leaves at the tip, which soon forms a plant as large as the one from which it originated, and in turn produces stolons; by such means dense groups

of plants of different generations remain organically united, and as the stolons are very strong, rowing boats and barges find it impossible to make headway, and steamers fare but little better, as the plants become entangled in the blades of the propeller. During floods large masses of the weed are detached and carried down stream as floating or half-submerged islands, which prove dangerous to bridges, jetties, etc. No satisfactory means of destroying the plant have as yet been devised. Some years ago certain rivers in Florida were completely choked up with this plant, which had been accidentally introduced. Specimens of the plant are at present growing in the Lily House, Kew Gardens.

ENGINEERING NOTES.

The excavation in Culebra Cut, Panama, in twenty-three working days in February amounted to 638,644 cubic yards. Had there been a full month the total would have been 722,000 yards, according to Chief Engineer John F. Stevens.

The great strength sometimes exhibited by brick masonry well laid in good cement mortar, is shown by a brick cistern 7 feet in diameter by 10 feet deep, which according to the Engineering Record, was undermined by a flood at Terre Haute, Ind., and floated away for some distance, without breakage of any part of the masonry or water gaining access to the interior.

For locomotive boiler use, water purification by means of the continuous system is the more satisfactory and economical method, as compared with the intermittent process on account of less labor, space, machinery and pumping required, where the analyses of well and river waters vary slightly and are fairly constant. The chemicals used are usually soda ash and lime, which are the most economical in first cost, and give equally good results as those, the cost for which makes their use prohibitive.

The Hamburg-American Steamship Company have placed an order with Messrs. Harland & Wolff, the eminent Belfast shipbuilders, for a new vessel intended for the transatlantic traffic between New York and Europe. The vessel is to be christened "George Washington," and in the event of proving successful will form the first of a new class of liner for this trade. The vessel is to be the largest twin-screw steamer that has yet been designed, and will be of the express passenger type. Among the many new features that are to be introduced for the comfort of the passengers will be a swimming bath, while a restaurant similar to that upon the "Amerika," and which has proved so successful, will also be provided. The vessel is to be ready for service for the spring traffic of next year.

For operating gas engines on board ship, producers must have means for keeping up the temperature in the producer while the engine is running at slow speeds or stopping, since otherwise it will not start up again on account of lack of suitable gas. This can be readily obtained by keeping up the rate of gasification through the exhausting fan and returning the gas into the producer where it is consumed again, there being practically no loss but that of the sensible heat of the gas radiating through the piping and, of course, the power required for driving the fan. No producer can be regarded as up to date that does not embody means for automatically adjusting the amount of water or steam admitted together with the air into the fire bed in fixed proportions according to the load, since without this arrangement, the fire will grow dead at the lower loads and the engine will not be able to pull up to a higher load again when necessary. There are a great many questions that are yet unsettled, and await solution in producer theory and practice.

Suction plants will work in the smallest sizes as economically as in the larger, and, of course, vastly more so than the largest and best equipped steam plants. They occupy very little space and may be installed in the basement of apartment and other houses without being at all dangerous or difficult to handle. Naturally the attendant must possess a degree of intelligence and training similar to one running a steam engine, though besides removing the ashes once a day his occupation only consists in filling the hopper with fresh fuel once or twice every two hours. The rest of the plant is self-regulating and needs no attention. Starting from cold does not require more than from ten to fifteen minutes. The smoke nuisance which is sometimes so objectionable in cities, is completely eliminated for all grades of coal that can be gasified. The personal equation is greatly reduced, since the process of gasification is not dependent on the skill of the fireman. Stand-by losses are also very low compared to steam plants. For small work and very intermittent working oil and alcohol engines are superior, since with them fuel consumption stops entirely as soon as the engine is shut down.

According to Machinery, Edward Pergoli and James Flood of New York were recently found guilty and fined $100 each for "stealing trade secrets," and the action of the lower court has been sustained by the Court of Special Sessions. The action is based on the anti-tipping law passed by the New York Legislature in 1906 which prohibits any gift or gratuity being given to an employe with the intent of influencing his action in a manner detrimental to his employer's business. It seems that Flood, the superintendent of a tobacco concern, with Pergoli persuaded a young man named Durand to secure a position in a tin-foil factory for the purpose of discovering secrets of manufacture, and disclosing them to Flood and Pergoli.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid. $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,

361 Broadway, New York, N. Y.

TABLE OF CONTENTS.